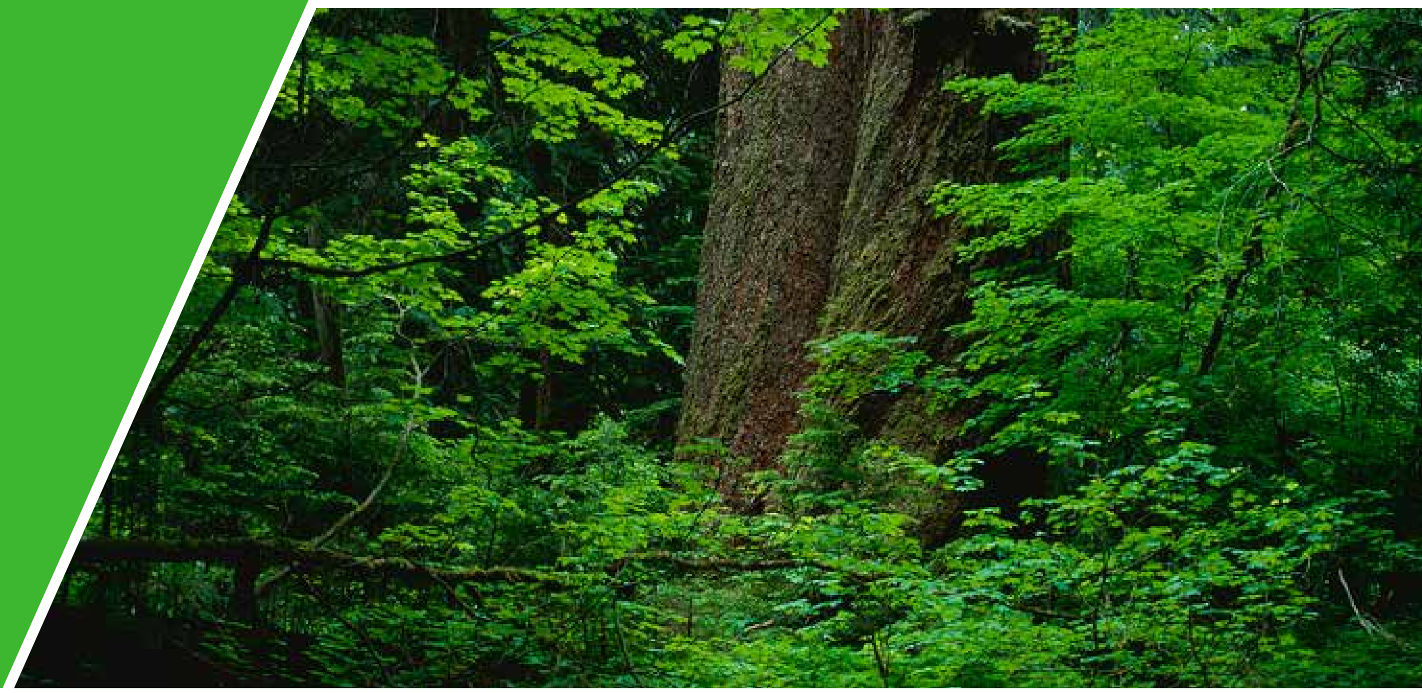
FORESTS FOR SUSTAINABLE DEVELOPMENT
THE ROLE OF RESEARCH

IUFRO-AO
2016



IUFRO Regional Congress for Asia and Oceania 2016

October 24–27, 2016
Beijing, China

ABSTRACTS

www.iufro-ao2016.org

IUFRO

CHINESE ACADEMY OF FORESTRY
中国林业科学研究院

Forests for Sustainable Development
The Role of Research

IUFRO Regional Congress for Asia and Oceania 2016

Abstracts

Hosts:
International Union of Forest Research Organizations (IUFRO)
Chinese Academy of Forestry (CAF)

Organizer:
Chinese Academy of Forestry (CAF)

Co-Organizers:
Chinese Society of Forestry (CSF)
State Key Laboratory of Tree Genetics and Breeding (SKLTGB)

China National Convention Centre, Beijing, China

October 24-27, 2016

Preface

Welcome to the IUFRO Regional Congress for Asia and Oceania 2016 which is held at China National Convention Centre in Beijing, China on October 24-27, 2016. The Congress is hosted by IUFRO and the Chinese Academy of Forestry (CAF), and organized by CAF.

Entitled as "Forests for Sustainable Development: The Role of Research", this Congress is the first regional congress of IUFRO in the Asia Pacific Region and the largest regional congress in the history of IUFRO in terms of the number of participants, scientific sessions, oral and poster presentations. We have around 100 scientific sessions in 9 time slots with about 11 concurrent scientific sessions each time slot. We have 476 oral presentations and 192 poster presentations. We also have streams of All Division 8 Conference and the 4th Forest Science Forum as a part of the Congress.

The Congress Scientific Committee (CSC) is chaired by Liu Shirong, and includes IUFRO's two vice-Presidents (Björn Hånell and John Parrotta), representatives of each of IUFRO's nine Divisions (Pil Sun Park, Yousry El-Kassaby, Woodam Chung, Lidija Zadnik-Stirn, Andrew Wong, Cecil Konijnendijk van den Bosch, Eckehard Brockerhoff, Jean-Michel Carnus and Mercy Derkyi), and a representative of the Asia Pacific Association of Forestry Research Institutions (Jung-Hwan Park).

We are very pleasured to present this collection of abstracts of plenary keynote, oral and poster presentations which constitute the Congress scientific program. We thank all of these colleagues, as well as member of Congress Organizing Committee and colleagues from IUFRO Headquarters in Vienna for their unstinting support to the work of the Congress Scientific Committee.

Since quite many oral and poster presenters requested us for revising, re-submitting their abstracts. Many others changed their decisions of whether or not they will eventually attend the Congress, so their abstracts were firstly removed but later re-listed. This leads to the very late closure of the collection of abstracts, only 10 days prior to the Congress. Furthermore, different people use quite different formats of abstracts, from the title, name and organization, main text to keywords and contact emails. It takes quite a lot of time to try to make them in consistency.

As we have to reserve at least one week for printing the abstracts, so we just have a rough editing, focusing only on the layout format with some efforts of consistency, and really do not have time for proof-reading over so many abstracts. As such, and due to such a short time, the final version of printed abstracts are still quite imperfect, but it should be still quite useful for all participants to have a better understanding of the main content of all oral and poster presenters. We will also have an electronic version of abstracts, and will put them on our Congress website (www.iufro-ao2016.org) prior the Congress with some improved quality (although still not perfect).

Regardless of your particular areas of interest and scientific expertise, we hope that this volume of abstracts will encourage you to explore and expand your interests in abroad array of contemporary topics in forest science.

Congress Organizing Committee
October 17, 2016

Contents

Congress Keynote Presentations

Congress Keynote Presentations

Latest progresses of silviculture research in China

Zhang Shougong
Chinese Academy of Forestry

China has achieved a dualistic growth in terms of forest quantity and quality in recent three decades through enormous efforts made to establish new planted forests and conserve natural forests, which have helped improve the country's forest productivity and enhance its forest ecosystem services to a significant extent. Forest science and technology contributes an indispensable part in accomplishing such remarkable achievements. A number of important progresses have been made in silviculture research in China. Firstly, 9 Experimental and Demonstration Sites for Sustainable Forest Management have been established in different forest regions in China, which are bases to explore technologies such as the structured management for natural forests, the close-to-nature management for planted forests, and the silviculture of multi-purposes forests etc, leading to a transformation from focusing only on wood production towards maximized economic, ecological and social benefits delivered by forests. Secondly, a total of 226 National Bases for Improved Materials of Forest Trees have been built across China, which have collected and preserved core germplasm resources of major species, e.g. Cunninghamia lanceolata, Pinus massoniana, Larix spp., Populus spp., Eucalyptus spp. etc, where researches on molecular mechanism of wood formation, resistance breeding of forest trees, advanced generation breeding and associated technologies are carried out, and a number of new and/or improved varieties have been developed. Thirdly, significant progresses have been made in researches on forest structure and functions, ecological restoration of degraded ecosystem by forests, and climate change impacts on forest biodiversity, and in total 110 Long-term Forest Ecosystem Research Stations are established nationwide in typical biomes in China. Fourthly, characteristic and new forest-related technologies have been addressed, such as those for cultivation of bamboo forests, mangrove conservation, aerial seeding to plant trees, afforestation in desertification-prone zones, forest-dominated vegetation restoration in dry and hot valleys in Yangtze River watershed, establishment of shelterbelt forests along the railway in sandy areas of dry region, forest health monitoring and early warning system, forest remote sensing, and establishment of nature reserves etc.

Research and development for sustainable forest in Asia

Don Koo Lee
Seoul National University, Korea

Forest and trees have indispensable roles in human being and the environment, which includes provision of good timber and non-timber products, beautiful landscapes, amenities for recreation and healing, water resources, biodiversity and among others. In Asia, despite its diversity in culture, life, society, religion, policy and population, the role of trees cannot be set aside. In addition, aside from being the center of civilization, Asia has plenty of natural resources with lots of potentials for ecological, social and economic gain (e.g. sustainable agriculture started first in Asia through rice culture in the paddy). Therefore, forest sustainability from generation to generation is important. Much attention to young people must be given attention, including women in forestry. To attain this, there is a need to strengthen research and education for sustainable forest in Asia. Development for economic growth without environmental degradation should be the main goal of each country. However, global as well as Asian challenges are continuously bombarding us, including climate change, land/soil degradation, water shortage, natural disasters, poverty, health, disease, insect, unbalanced food supply, pollution, urbanization, among others. Hence, the roadmap for sustainability will be tackled considering the attainment of 17 Sustainable Development Goals (SDGs) at the local and global level. Furthermore, ways on how to achieve sustainable future forest in Asia will be dealt with, sharing the Korea’s success story highlighting the human resources capacity building as a success model, Minnesota Plan (for education) practiced/World Bank Loan (for research) for National Instrumentation Center for Environmental Management (NICEM) at Seoul National University (SNU), and success story of reforestation due to peoples' willingness, good governance, "CAN do spirit" (diligence, self-help, cooperation, service, sharing, creativity) by Saemaul Undong, and the role of green leaders.

How far should we go “native”?
Re-conceptualizing biodiversity restoration in urban forests

Makoto Yokohari
University of Tokyo, Japan

Restoring biodiversity by reforesting urban fabrics is one of common urgent tasks for cities in the world. Tokyo is not an exception. A number of redevelopment projects recently taken place in downtown Tokyo include reforested green patches at the foot of skyscrapers by having biodiversity as one of their key concerns. In such projects native species which used to dominate the area before major urban development occurred have been invited, while the use of introduced and horticultural species has strictly been prohibited.

However, because of the heat accumulation in the city center the average temperature of Tokyo has sharply been raising; 13.6C back in early 1900s is now over 17.0C. About 100 years ago Tokyo’s average temperature was almost the same with the current temperature of Sendai City, 300km north of Tokyo, while the temperature today is almost equivalent to that of Ohita City, 900km southwest of Tokyo. By having such climate change we may have to understand that species which used to be “native” to Tokyo are no longer so, as the city today is too hot for those species to comfortably survive. Contrary, Tokyo is becoming to be an ideal habitat for species introduced from southern Japan and even for tropical species.

Human comfort is another perspective that should be taken into account when designing reforestation patches. Even though the restoration of biodiversity is becoming indispensable, urban forests are primarily the places for recreational uses. However, vegetation with native species is not always in line with human comfort, as their complexed visual appearances tend to be negatively regarded as “messy” by the general public.

By referring to prominent reforestation projects recently taken place in downtown Tokyo, as well as in North American and European cities, this paper argues how reforestation projects aiming to restore biodiversity should be conducted by re-conceptualizing “urban” biodiversity and “native” species.

Forests and the bioeconomy: challenges and opportunities

Elspeth MacRae
Scion (New Zealand Forest Research Institute)

While people discuss the need for a 70% increase in the amount of food available for a 2050 world, few people are aware of the estimated 300-plus percent increase needed in wood fibre (WWF report 2012). The extent of this anticipated demand presents considerable challenges for plantation forests as the preferred main source of fibre. The bioeconomy and development of biorefineries is driving new applications such as provision of bioenergy and new kinds of bioproducts, both substitutions for petrochemical products and products with new attributes due to the more diverse starting material. Some of the most common biopolymers in the world are yielded from trees, e.g. cellulose (tightly packed carbohydrates and the most common polymer on the planet) as a resource for remanufacture or use as micro and nanofibres, and lignin, which is the most common biological aromatic resource on the planet, being also the resource of millennia for coal and oil. There are challenges, more for softwoods than hardwoods, in the processing and reduction of cellulose and hemicellulose to sugars for onwards fermentation, or the modification of lignin to make new products, but economic solutions are increasing.

Designing trees as factories, maybe with different planting approaches, also enables a wealth of opportunities in how a tree may be viewed in contrast to the more traditional view of trees as a source of wood for building, furniture and cooking fuel, and fibre for paper and packaging. The limitation on the application of these technologies is national legislation and market responses, including uptake of biotechnological solutions.

Congress Oral Presentations

Congress Oral Presentations

Session A-01 (45): Tackling climate change adaptation in tropical and subtropical forests

Adaptive forest management in China: climate change impacts, silvicultural options and transformations

Liu Shirong, Wang Hui, Yang Yujing
Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

The forest, as an important component of terrestrial ecosystem, plays a major role in global carbon cycle. Climate change has affected forest ecosystems in China through a long term observed changes in vegetation phenology, tree growth, species distribution, forest structure and species composition, forest productivity, and forest pest and disease outbreaks and forest fire regimes. Projections of climate change also suggest profound impacts of climate change on forest ecosystem structure and functions, jeopardizing forest mitigation potential and other ecosystem services. Since forest carbon sequestration is important and sensitive to climate change, proactive forests management strategies are imperatively needed to mitigate and adapt climate change by adopting appropriate silvicultural options and transformations to enhance the capacity of forests as carbon sink and its resilience to cope with the changing climate. Such adaptive forest management measures in China include: 1) strengthening the monitoring and assessment of forests across different geographical gradients in response to climate change; 2) selecting suitable tree species for afforestation and reforestation and transforming the existing pure forests into mixed plantations; 3) encouraging natural ecological restoration of degraded forest lands while protecting the existing natural forests; 4) improving the capacity building of forest pest/disease/fire forewarning and prevention and control ability; and 5) adjusting silvicultural regime to multiple purpose forest management. Importantly, forestry agencies at all levels should give an equal high priority to forest adaptation as forest mitigation and put concrete measures in place in order to enhance forest resilience and carbon sink capacity while reducing the likely negative impacts of climate change on forests, which is essential for sustaining multiple forest ecosystem provided for sustainable development and human wellbeing under a changing climate.

Email: liusr@caf.ac.cn

Integration of climate and ecological modeling tools for adaptive management in Asia-Pacific forests

Guangyu Wang[1], Tongli Wang[1], Kang Haijun[2], Shari Mang[1], Brianne Riehl[1], Brad Seely[1], Liu Shirong[3], Guo Futao[2], Li Qinglin[1], John Innes[1]
1. Faculty of Forestry, University of British Columbia
2. College of Forestry, Fujian Agriculture and Forestry University
3. Chinese Academy of Forestry

Climate change is an immense threat to the stability and productivity of forest ecosystems in the Asia-Pacific region. Potential changes to or loss of forests will have drastic environmental impacts on biodiversity, ecosystem function and resilience, as well as immense socio-economic impacts on people and economies dependent on forest resources and ecosystem services. Despite their importance, there is a lack of information and tools focused on Asia-Pacific ecosystems and economies, which are necessary to understand the potential effects of climate change and develop regionally-specific adaptation and mitigation strategies. The project Adaptation of Asia-Pacific Forests to Climate Change aims to address this lack of knowledge and tools and to increase the adaptive capacity of Asia-Pacific forest ecosystems. This objective has been achieved through: development of a high-resolution climate model, ClimateAP, applicable to any location in the region; development of ecological models to project how climate change will affect suitable climatic conditions, regeneration, and productivity of forest tree species; development of tools to assess the most effective local management strategy based on management objectives and projected impacts of climate change; evaluation of models to assess forest fire risk and the relationship between forest fire and climate change; assessment of ecosystem carbon storage using LiDAR; and evaluation of how vegetation dynamics respond to climate change using remote sensing technology. All project outputs were developed with ease of communication in mind, as to ensure that information can be clearly disseminated and easily understood. This is necessary to allow for project findings to be used in the development of effective policy and sustainable forest management strategies related to adaptation and mitigation of forests to climate change.

Email: guangyu.wang@ubc.ca

Ecosystem goods and services in adaptation to climate changes insights from the Panchase mountain ecological region of Western Nepal

Shankar Adhikari
Ministry of Forests and Soil Conservation

Ecosystem goods and services (EGS) from forests are critical to tackle climate change and improve human well-being especially in developing countries. However, various natural and anthropogenic drivers of environmental and climate changes have posed challenges to the sustainable supply of EGS. Improved understanding of interactions between EGS and these drivers is required to help people cope with the challenges because interaction between multiple drivers and EGS are largely unknown. To better understand the role of EGS in adaptation to environmental and climate change, and enhance human well-being, this study applies IPBES conceptual framework, using a catchment of the Panchase Mountain Ecological Region (PMER) in Western Nepal as a case study. Major natural drivers of change were identified as climate change, drought, and invasive species, whereas anthropogenic drivers included agriculture land abandonment, plantation of new species, and demographic changes. All drivers were found to impact the availability of EGS, and livelihoods of people reliant on them. Current anthropogenic assets and institutional mechanisms were found to be effective in managing some of the challenges. Proper governance and adequate financial and technical support seem essential for addressing environmental challenges that influence the sustained flow of EGS in the region.

Email: adhikarishankar@gmail.com

Adapting forest management for climate change in Australia: practices, prospects and policies

Rodney Keenan
University of Melbourne

Australia has a highly diverse and variable climate and its forests are well-adapted to climatic variation. However, human-induced changes in climate could exceed historical ranges of variability and have effects on forests well beyond the experience of forest managers. These conditions will require implementation of management practices appropriate to a changing climate. While many management actions to support adaptation to climate change can be considered as part of best practice sustainable forest management arrangements, others are not. These include developing gene management programs and off-site gene banks, ex-situ conservation and increasing wider cooperation in species management, increasing stand and regional species diversity, identification and deployment of more drought or disturbance tolerant species or genotypes, planning for reduced disease losses through monitoring and sanitation harvests, managing stand structure to reduce impacts on water availability and implementing silvicultural techniques to promote stand vigour, as practiced elsewhere in Australia. More intense rainfall and storm events will require changes to infrastructure, such as forest road design and construction specifications. This paper presents an overview of practices to address future climate impacts and a framework for assessing the costs and benefits of prospective new practices. The policy changes required to support their implementation are discussed.

Email: rkeenan@unimelb.edu.au

Effects of imposed drought on carbon storage of moso bamboo ecosystem in southeast China

Zhou Benzhi[1], Ge Xiaogai[1], Li Qian[1], Lianhong Gu[2]
1. Research Institute of Subtropical Forestry, Chinese Academy of Forestry
2. Environmental Sciences Division, Oak Ridge National Laboratory,

Drought, a common climatic extreme event, could occur more frequently and more intensely in the context of climate change. Soil water deficit will result in the alteration of cycling of water and carbon in forest ecosystems. In the present work, we assessed imposed drought effect on carbon storage and soil carbon dynamics in a moso bamboo forest ecosystem in a subtropical area of China using a throughfall exclusion experiment during the period between July 2012 and June 2013. The number of bamboo shoots, new bamboo culms, and the height and diameter at breast height were significantly lower in the throughfall exclusion (TE) plots than in the control (CK) plots. The carbon storage in the arborous layer in the TE plots decreased by 13.14% and 58.11%, respectively, while the litterfall increased by 6.19% when compared with the CK plots. A significant decrease in carbon storage occurred in TE plots in all soil layers except for the 10–20 cm layer. The imposed drought significantly deceased the carbon storage by 13.71 t·ha-1, whereas it increased by 4.75 t·ha-1 in the CK plots. This study will provide important information to quantify the potential for carbon sequestration and to understand how future climate change might impact carbon budgets.

Email: benzhi_zhou@126.com

Long-term climate trend and possible forest ecosystem changes in Malaysia

Siti Nurhidayu Abu Bakar
Universiti Putra Malaysia

Malaysian forest could be divided into more than ten ecosystem classes and each of it is unique and rich in its biodiversity in terms of flora and fauna. These classifications were defined based on elevation and major species as it determine the ecosystem of the forest. Several evidence on literature indicates the effects of climate change which altered the distribution of forest ecosystem in several regions in the world. This research investigates the long-term climate trend in Malaysia and observes any ecosystem shift from the modelled historical climate data using climate-niche modelling. In doing this, historical climate data modelling for the Asia-Pacific region including Malaysia was used. 30 years (1986-2015) of climate data (minimum and maximum monthly temperature and total monthly rainfall) from selected and distributed 25 Malaysian Meteorological Department (MMD) stations were used to characterise the climate trend for the whole country. Forest ecosystem classes maps were obtained from Peninsular Malaysia, Sarawak and Sabah Forestry Department, Malaysia combined with the additional information on the classes obtained from literature were digitised. The long-term climate characterisation indicates the increment of temperature and reduction of rainfall in several places in Peninsular Malaysia whereas a contrast trend was observed at several places in Borneo. The forest ecosystem shifting in Malaysia especially on higher elevation types of forest such as montane and sub-alpine forests will be discussed in this paper. These areas are known as the contributing areas for watershed and also habitat for unique and endangered flora and fauna species. The required adaptation strategies of the impacts of climate change should be planned for ecological and economic benefits in future.

Email: sitinurhidayu@upm.edu.my

Session B-01 (44): The target plant concept: a foundation for forest regeneration success

The target plant concept: a framework to enhance tree planting success

Anthony Davis[1], Rebecca A. Sheridan[2], Karma Bouazza[3]
1. College of Forestry, Oregon State University, Corvallis, OR, USA
2. Center for Forest Nursery and Seedling Research, University of Idaho, Moscow, Idaho, USA
3. Lebanon Reforestation Initiative, Beirut, Lebanon

Properly cultivated and selected seedlings can be one of the most effective ways to re-establish tree communities in afforestation, reforestation, or restoration projects. Traditionally, a unidirectional relationship existed, whereby the plant material used on a restoration site was provided by a standard, one-size-fits-all, process from the nursery. This particular method overlooks potential survival, performance, and growth gains that can be achieved by properly matching nursery stock to specific outplanting conditions. The Target Plant Concept (TPC) incorporates five variables: Objectives and Constraints, Limiting Factors on the Outplanting Site, Stocktype, Source of Plant Material, and Outplanting and Follow-up Practices that should be considered as determining factors for how, where, and when nursery stock are produced to address specific project parameters. Using the TPC as a model for successful seedling establishment, the procurement of plant material moves from being based on availability and economics to inclusion of specific seedling attributes that are likely to result in establishment

success. This presentation highlights the use of this framework through current research and operational examples and provides guidance for potential new, evolving, approaches.

Email:asdavis@uidaho.edu

Site evaluation, limiting factors, and mitigating measures: understanding your outplanting site to maximize outplanting success

Jeremiah Pinto[1], María Noelia Jiménez[2], Matthew M. Aghai[3]
1. Rocky Mountain Research Station
2. Institute of Agricultural Research and Training, Andalusian Government, Spain
3. University of Washington, Seattle, Washington, USA

In restoration, afforestation, and reforestation projects, outplanting environments pose a myriad of challenges to establishing seedlings. These environments often yield conditions beyond those deemed acceptable for natural reestablishment, or those conditions favorable for establishment by direct seeding. These challenges should be realized by land managers after a thorough site evaluation. Once the primary and most foreboding limitations to establishment are known, strategies can be employed to overcome them. In most cases, the primary limitation to seedling establishment is moisture availability, but other limiting factors might include: seedling quality, other plants, animals, extreme temperatures, lack of microorganisms, and even social/cultural issues. A model of seedling establishment outlines how seedlings engage their surroundings and begin to survive and grow on a site and thus guides research hypotheses. This model characterizes the physiologic, atmospheric, and edaphic process that factor into a target seedling's design, a primary strategy to overcome site limiting factors. A secondary strategy employs site preparation tactics and appropriate mitigating measures that further aid seedling establishment. In this session, site evaluation, limiting factors, and mitigating measures (including target plant material and site preparation) will be discussed and supported using research and case study information.

Email: jpinto@fs.fed.us

Genetic considerations in the nursery and the field under changing climates

Kasten Dumroese[1], Liu Yong[2]
1. United States Department of Agriculture Forest Service, Rocky Mountain Research Station Grassland, Shrubland, and Desert Ecosystems Science Program, Moscow, Idaho, USA
2. Key Laboratory for Silviculture and Conservation, Beijing Forestry University, Beijing, China

Forest restoration often requires the use of nursery-grown plant materials. To be successful, these plant materials must possess the physiological and morphological attributes necessary to overcome the particular environmental challenges of the site. Determining these attributes is the basis of the Target Plant Concept. A key aspect of the Target Plant Concept is identifying the appropriate genetics to be used. This can be challenging because empirical plant material transfer guidelines (employed to avoid maladaptation) may not be available for all the plant species desired for restoration. Provisional transfer guidelines can be used until empirical data can be obtained. A drawback of either of these approaches is that they are static on the landscape, and changes in climate will likely necessitate the use of more dynamic approaches in matching genetics with landscape position, and thus more fully realize benefits associated with

assisted migration. Once appropriate genetics for a site are determined and nursery production begins, care must be taken to ensure that subsequent genetic and sexual diversity of the crop is maintain, especially in response to climate change. Our presentation will focus on current activities in China and the USA.

Email: kdumroese@fs.fed.us

Re-evaluating the link between nursery systems and outplanting performance

Barbara Mariotti[1], Alberto Maltoni[1], Douglass F. Jacobs[2], Andrea Tani[1]
1. Department of Agricultural Food and Forestry Systems, Università degli Studi di Firenze, Italy
2. Hardwood Tree Improvement and Regeneration Center, Purdue University, USA

High quality seedlings can be used to enhance tree planting success in afforestation and reforestation projects. In container-based systems, the effect of container configuration and size can strongly influence seedling growth, structure, biomass allocation and subsequent outplanting performance. Considering the wide availability of different stocktype varieties, the first phase of this study was aimed on describing the influence of a wide range of container types (different sizes of currently used and alternative types) to identify the general effect in determining the development of seedling morphology, in order to produce plants for intensively managed plantations and/or for forest underplantings designed to produce high quality timber. Then, according to results, the study was focused on production of bigger seedlings grown in containers of greater volume than those currently used in forest nurseries. As tree planting projects enhance the connection between seedling production technique in the nursery and field site capacity at the outplanting site, and incorporate the "Target Seedling" approach, it is likely that establishment and growth rates will be improved. This presentation will highlight the effect of container size on seedling morphology, both in the nursery phase and after plantation establishment.

Email: barbara.mariotti@unifi.it

Evaluating bacterial endophytes as a nursery or field amendment for improving reforestation success

Matthew Aghai[1], Zareen Khan[2], Gregory J. Ettl[1], Sharon L. Doty[2]
1. Center for Sustainable Forestry at Pack Forest, School of Environmental and Forest Sciences, University of Washington, Seattle, WA, USA
2. Plant Microbiology Laboratory, School of Environmental and Forest Sciences, University of Washington, Seattle, WA, USA

To date, a plethora of reductionist analyses have demonstrated that the response of plants to shared resources from co-evolved microbiomes can result in adaptive phenotypic changes, stress mitigation, as well as improved plant immunity through direct and indirect mechanisms. Our research provides an assessment of bacterial endophytes for use in improving seedling growth and development in suboptimal environmental conditions. We evaluated *Pseudotsuga menzeisii* and *Thuja plicata* seedlings established and grown under greenhouse conditions, and then initiated field testing to determine if colonized plants have improved establishment potential when subject to common stressors including drought and nutrient deficiency. The use of natural plant-microbe symbiosis can be highly advantageous due to the ease of application of this

technique during cultivation or prior to out-planting, relatively low cost, and, increased nutrient acquisition as well as increased drought tolerance, growth, and overall health. Thus, successful inoculation of widely used conifer species with endophytes holds promise for increasing forest productivity and reforestation efficiency, particularly through a decrease in tending costs during early stand management. The results of this trial will inform nurseries, restoration ecologists, and the forest industry on the potential benefits of acquiring and deploying endophytes for improving reforestation success in other coniferous systems.

Email:aghai@uw.edu

Session C-01 (4): Impacts of changing climate and atmospheric deposition on forest ecosystem structure, function and management

Urban hotspots of sulfur, nitrogen and phosphorus deposition in China: characteristics and implications for forest management

EnzaiDu
State Key Laboratory of Earth Surface Processes and Resource Ecology, and College of Resources Science & Technology, Beijing Normal University

The acceleration of anthropogenic emissions in China has resulted in high levels of sulfur, nitrogen and phosphorus deposition, especially in and near large cities. However, knowledge gaps still exist in the way that large cities shape spatial patterns of atmospheric deposition of these elements. By synthesizing data on sulfur, nitrogen and phosphorus in bulk precipitation and throughfall in Chinas forests, the status and characteristics of atmospheric deposition of these elements were assessed. Fluxes of sulfur, nitrogen and phosphorus in bulk precipitation and throughfall exhibited a power-law increase with a closer distance to the nearest large cities, implying significant urban hotspots of atmospheric deposition of these elements. The high N:P deposition ratios indicated a potential of nutrient imbalance induced by atmospheric deposition. The results suggest an anthropogenic alternation of regional sulfur, nitrogen and phosphorus cycling, which might threat health and function of large areas of China’s forests especially in southern China.

Email: enzaidu@bnu.edu.cn

Effects of climate change and overgrazing on leaf area dynamics in the upper reach of Heihe river basin, northwestern China

Hao Lu[1], Liu Peilong[1], Zhou Decheng[1], Pan Cen[1], Ge Sun[2], Yongqiang Liu[3]
1. International Center for Ecology, Meteorology, and Environment, Nanjing University of Information Science and Technology
2. Eastern Forest Environmental Threat Assessment Center, USDA Forest Service
3. Center for Forest Disturbance Science, USDA Forest Service

The Leaf Area Index (LAI) is an important vegetation parameter to understand the global atmosphere/biosphere interactions and is widely used to simulate the land surface processes in Earth system climate models. Accurately quantifying the response of spatially and temporally

continuous of LAI to climate change and human activities is the first step for characterizing the dynamics of mass, water and energy exchanges between vegetation and the atmosphere. This case study examined the responses of LAI to the climate change and overgrazing during 1983–2013 in the upper reach of Heihe River basin in northwestern China. The Heihe basin is facing multiple sociohydrological challenges in water supply ecological restoration and is one of the most extensively studied inland river system in China. We found an increase trend in mean LAI as determined from remote sensing products, especially during the vegetation growing season during the past three decades. The increased LAI was attributed to the extended vegetation growing season due to the increase in temperatures and precipitation. Ecological restoration policies and measures also improved the vegetation coverage, and promoted forest and grassland ecosystem recovery in high altitude mountainous areas. Grassland grazing exclusion on alpine meadow is a positive factor for the increase of LAI, but intensive overgrazing in some areas caused a decrease in LAI. The growing season LAI had significantly positive correlations with mean minimum temperature and precipitation (R = 0.55, p = 0.01, and R = 0.50, p = 0.025 respectively), but weak negative correlations with overgrazing rate (R = -0.32, p = 0.16) at the basin scale during 1983–2013. Overall, the positive effects of regional climate warming and climate variability overwhelmed the negative effects of overgrazing.

Email: hl_haolu@163.com

The effects of nitrogen deposition and phosphorus on fine root production of hybrid larch F_1seedlings

Saki Fujita[1], Kazuhito Kita[2], Takayoshi Koike[1]
1. Hokkaido University Graduate School of Agriculture
2. Hokkaido Forestry Research Institute

Fine roots (diameter < 2mm) play an important role in the absorption of nutrients and water from the soil, and support plant growth. However, the soil environment of plants is rapidly changing due to nitrogen deposition caused by human activities. Nitrogen deposition works as a nutrient when the soil is nitrogen deficient, however, as the deposition amount increases, it will only cause nitrogen to increase and therefore the collapsing balance between nitrogen and other nutrients especially phosphorus, causing the nitrogen/phosphorus ratio to increase. Phosphorus is an important nutrient and is essential for new root production. In this experiment, we used hybrid larch F_1, which represents an important afforestation species in Hokkaido. Here, we added nitrogen and phosphorus to examine the effects of the change in N/P ratio due to nitrogen deposition on fine root production. We focused on the fine root production since fine roots are indispensable for phosphorus acquisition. We used the core sampling method to destructively obtain the fine roots. As a result, we discovered that fine root production is reduced by nitrogen deposition, and this was not dependent on the amount of phosphorus. However, phosphorus had significant effects on other measured above ground parameters.

Email: gaiasilva915@eis.hokudai.ac.jp

Water use efficiency responses of Australia’s forest ecosystems to drought

Liu Ning[1,2], Richard Harper[1,2], Liu Shirong[2], Bernard Dell[1]
1. School of Veterinary and Life Sciences, Murdoch University, Australia
2. Chinese Academy of Forestry, Beijing, China

Over the past 100 years, Australia has experienced pronounced climate change, especially in forested areas where a dramatic reduction trend (up to -5 mm/year) of rainfall was observed. However, the responses of Australia's forest to this rainfall decline have not been fully understood, with observations of both increased vigour and and dieback. To better understand the dynamics and responses of Australia's forest ecosystem to climate change, the magnitude and trend of water use efficiency (WUE) (gross primary productivity (GPP)/evapotranspiration (ET)) of forest, and its responses to drought were analysed. GPP was derived from MODIS's GPP product, while ET was derived from MODIS's ET product and a distributed water balance model (AWRA-L). The result showed that during the period 2000 to 2014, the national averaged annual WUE of forest was 2.65 ± 0.65 g C kg-1 H2O. Both ET and GPP increased during this period, whereas annual WUE slightly decreased (-0.01 g C kg-1 H2O year-1), because the increase of ET was larger than GPP. The drought increased annual WUE in southwest Australia but decreased annual WUE in southeast of Australia. The cumulative lagged effect of drought on monthly WUE was relatively short (~3 months). The drought has significant impacts on forest's WUE, whereas, how drought's frequency and severity affect this should be further analysed.

Email: ln1267@gmail.com

Impact of changing meteorology and air pollution on forest ecosystems in Lithuania – strategies for adaptation to and mitigation of the main threats of global change

Algirdas Augustaitis[1], Vitas Marozas[1], Gintautas Mozgeris[1], Vidmantas Ulevičius[2], Steigvilė Bičenkienė[2], Genrik Mordas[1], Manuela Baumgarten[3], Rainer Matyssek[3]
1. Aleksandras Stulginskis University, Kaunas Lithuania
2. Centers of Physical Sciences and Technology, Vilnius, Lithuania;
3. Technical University of Munich, Germany

Global change in Lithuania is predicted to promote increasing air temperature across seasons, a decrease in snow cover and an increase in heavy rain events. Changes in atmospheric circulation reduce seasonal climatic amplitudes, but enhance air pollution presumably tropospheric ozone, acidification and biogenic volatile organic compounds (BVOC) which will impact on tree growth and ecosystem performance. To mitigate main threats of global change the objective of the recently established comprehensive survey in Lithuanian forests is to develop strategies for silvicultural management in order to prepare forest systems ensuring ecosystem services.

Intensive investigations at selected forest sites combine growth and injury analysis with ecophysiological assessments of tree water consumption, stomatal regulation and stomatal uptake of ozone, and tree bound BVOC emissions. Combining such investigations with long-term monitoring on environmental pollution and regional peculiarities in Lithuania insight is gathered on tree growth in dependence of environmental stress. The combination of knowledge on tree growth, ecophysiolocal performance and methods of BSOA formation will provide a diagnostic tool for differential stress diagnosis and treatment measures under the specific requirements of Lithuania.

Email: algirdas.augustaitis@asu.lt

Soil respiration of Larix gmelinii Rupr. forest and the responses to fire disturbance in Da Xing'an mountain China

Sun Long[1], Hu Tongxin[1], David Weise[2], Futao Guo[3], Hu Haiqing[1]
1. Northeast Forestry University
2. USDA Forest Service, PSW Research Station
3. College of Forestry, Fujian Agriculture and Forestry University

This study examines the effect of fire intensity on soil respiration under Larix gmelinii Rupr. stands. The study quantified the dynamics of growing season soil respiration (autotrophic (Ra) and heterotrophic (Rh)), determined effects of fire intensity on soil respiration; and examined the relationship among growing season soil respiration, temperature, and moisture. We established five study plots within an area burned by lightning-caused wildfires and an adjacent unburnt control in *Larix gmelinii* stands on Da Xing'an Mountain. Two high intensity, two low intensity and one unburned control comprised the five study areas. Ra and annual soil respiration (Rs) were measured for three years in each study area. Exponential regression was used to estimate Rs from soil temperature and moisture content. Compared with the unburned control, average soil respiration declined by 22-25% in the burned areas. Annual Rs flux ranged from 657 to 927 g Cm-2y-1. Annual Rs flux in the burnt forest was 76% of the unburnt forest flux. The exponential regressions accounted for 28 to 75% of the variation in average Rs and 43 to 60% in average Rh. Fire severity did not have a significant impact on the soil respiration average temperature coefficient (Q10).

Email: sunlong365@126.com

The legacy effect of drought on forest phenology

Lianhong Gu
Oak Ridge National Laboratory, Oak Ridge, TN, US

Although drought events have limited duration, their impact on ecosystem structure and functioning can persist long after the events have gong. Due to a lack of long-term observations, it is not clear at present how ecosystem phenology is affected by the legacy of drought. The unique datasets obtained at the Missouri Ozark AmeriFlux (MOFLUX) site offer an opportunity to address this question. Since the establishment of the MOFLUX site in 2004, a wide range of precipitation regimes from abundant rain to extreme drought occurred at the MOFLUX site, resulting in large inter-annual fluctuations in plant water stress levels. In particular, several drought events with varying drought intensity occurred during the study period. The 2012 drought was the strongest category D4 (Exceptional Drought), according to the US Drought Monitor Classification Scheme and offered a contrast to earlier, less severe droughts. In this presentation, we will use a suite of indices to characterize how MOFLUX forest functional phenology is affected by droughts with different severities. These indices include spring photosynthesis development velocity, fall photosynthesis recession velocity, growing season initiation day, growing season termination day, center day of the growing season, length of the growing season, effective length of the growing season, effective daily maximum canopy photosynthetic rate, and seasonal carbon dioxide assimilation potential index. We will show that legacy effects on these indices can still be detected years after a drought.

Email: gu.lianhong@gmail.com

Impacts of drought, photosynthetic productivity and competition on the radial growth of white spruce in western Canada

Syed Ashraful Alam[1,7], Jian-Guo Huang[1], Kenneth J. Stadt[2], Philip G. Comeau[3], Andria Dawson[4], Guillermo Gea-Izquierdo[5], Tuomas Aakala[6], Teemu Hölttä[6], Timo Vesala[7,6], Annikki Mäkelä[6], Frank Berninger[6]

1. Key Laboratory of Vegetation Restoration and Management of Degraded Ecosystems, South China Botanical Garden, Chinese Academy of Sciences, Guangzhou, China
2. Forest Management Branch, Sustainable Resource Development, Edmonton, Alberta, Canada
3. Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada
4. Department of Statistics, University of California, Berkeley, CA, USA
5. INIA-CIFOR, Ctra. La Coruña km 7.5, 28040 Madrid, Spain
6. Department of Forest Sciences, P.O. Box 27, FI-00014, University of Helsinki, Finland
7. Department of Physics, University of Helsinki, P.O. Box 48, FI-00014, University of Helsinki, Finland

Under projected climate change scenarios, drought-induced tree mortality is expected to increase worldwide and depending on the drought conditions, trees generally reveal a distinct reduction in radial growth. Therefore, it is critical to understand the interactions of drought, photosynthetic productivity and tree-tree competition, and their effects on the radial growth of trees.

Using a mixed modelling approach, and a stand level photosynthetic production model with the climate, tree-ring and stand competition data from the mixedwood stands of western Canada, we were able to understand the combined effects of drought, photosynthetic productivity and competition on the radial growth of white spruce (Picea glauca). Average radial growth of white spruce largely constrained by drought and competition. Competition and drought diminished the positive effects of warming on the radial growth of trees. While dominant trees were more sensitive to interannual variations of gross photosynthetic productivity, the interannual variations of drought yielded similar effects on suppressed and dominant trees.

Our work is novel since it is the first study that looked on the combined effects of photosynthetic productivity, drought and competition on the radial growth of white spruce, and the results could contribute to advance our understanding on sustainable management of boreal forests, globally.

Email: ashraful.alam@helsinki.fi

Session E-01 (35): Sustainable biomass operations to facilitate forest and landscape rehabilitation and restoration

Maintaining and improving soil and site productivity during bioenergy harvest operations

Deborah Page-Dumroese
USDA Forest Service

Fuel reduction or bioenergy harvest operations that make use of thinning, slash management, and underburning can potentially impact the soil resource by removing the forest floor, displacing topsoil layers, and/or causing mineral soil compaction. The extent of those impacts on soil porosity, organic matter (OM), carbon (C), nitrogen (N), and residual coarse wood levels within a harvest unit or across a watershed will subsequently determine if net primary productivity and soil and site hydrology are affected. Understanding the changes in soil biological, chemical, and physical properties that affect soil after disturbance are important for restoring or maintaining ecosystem function and for successful implementation of best management practices that minimize the potential for long-term or cumulative effects. In addition, management of woody residues to reduce fire hazard while maintaining an adequate amount to provide for ecological function can be a site specific balancing act. Existing soil maps, site stratification systems, and disturbance risk ratings can be used to efficiently evaluate a site prior to, or during, a field visit to determine if soils are resilient or sensitive to management activities. Best management practices can then be prescribed to increase the potential positive benefits and minimize potential negative effects of planned activities. In addition, using biochar as a method of soil restoration after harvesting can provide one mechanisms for increasing soil water holding capacity, reducing tree stress, and improving nutrient cycling.

Email: ddumroese@fs.fed.us

Current state and issues of planted forests in the Northern Mongolia

Sukhbaatar Gerelbaatar[1], Ganbaatar Batsaikhan[2], Tseveen Batchuluun[1], Demberel Munguntsetseg[1]

1. Department of Environment and Forestry Engineering, National University of Mongolia

2. Division of Forest Resources and Conservation, Institute of Geography and Geoecology, Mongolian Academy of Sciences

This paper assesses the current state and issues of planted forests in the northern Mongolia using field measurements in planted forests of Tuv, Selenge, Bulgan and Darkhan–Uul provinces. We also analyzed the relevant reforestation data taken from Ministry of Nature, Environment, Green Development and Tourism (MNEGDT) and Forest Research and Development Center (FRDC) of Mongolia. The investigation resulted that, there is an unbalanced critical volume ratio between forest utilization and restoration activities in Mongolia in recent decades. The current volume of forest area affected by harvesting and other disturbances was much higher than rehabilitated areas. Such low amount of reforestation and intensive utilization of forest resources create the pre-conditions of rapid deforestation across the country. We also found a different level of survival and growth of planted trees with plantation age. A massive mortality of seedlings observed during the first year of plantation establishment due to lack of precipitation and intensifying aridity. Annual increment of planted trees strongly correlated with each year amount of rainfall during growing season. Current global warming and the ever-increasing aridity become one of main limiting factors which affect the success of forest restoration and might cause the low productive, ecologically and economically less beneficial plantations. Furthermore, results of the assessments suggest the importance of creation of forest plantation datasets and monitoring system in state and provincial levels and introduce an appropriate well-drought-adapted planting technology in forest restoration.

Email: gerelbaatar@seas.num.edu.mn

Application of a risk-based framework for restoration prioritization to wildfire mitigation that includes biomass utilization

Matthew Thompson, Nathaniel Anderson
US Forest Service

This presentation will introduce a risk-based framework for prioritizing landscape-scale forest restoration operations, and illustrate its application in the context of wildfire risk mitigation. The prioritization schema can be distilled into three primary questions: (1) where are risks highest and restoration needs greatest; (2) can restoration treatments sufficiently mitigate risks; and (3) are restoration treatments likely to be economically viable? Several critical themes underlie restoration cost-effectiveness, and this framework attempts to operationalize those themes in decision making. First, the uncertainty surrounding wildfire activity suggests the need for a probabilistic framework. Second, the relative rarity of wildfire and the commensurate low probability of any given restored area burning in any given year suggest a need for large-scale treatment. Third, the need for large-scale treatments coupled with the difficulty in financing such treatments suggests a commensurate need for offsetting treatment costs with biomass harvesting revenues. Implementation of the framework is premised on interdisciplinary collaboration merging concepts from forest economics, forest operations and logistics, biomass utilization, and risk and decision analysis. Successfully integrating these branches of forest management research will ideally allow for broader perspectives and strong insights into how to prioritize increased application of silvicultural treatments to restore and sustain working landscapes.

Email:mpthompson02@fs.fed.us

Economic feasibility of mangrove restoration through sylvofishery in the southeastern coast of Bangladesh

Mohammad Mahfuzur Rahman, Mohammed Abdullah Al Mahmud
Institute of Forestry and Environmental Sciences, University of Chittagong

Chakaria Sundarban (CSB) of Bangladesh was the oldest mangrove forest in the Indian Sub-continent. The forest was willfully destroyed through shrimp farming, salt panning, and human settlement. The same happen to the mangroves of Maheshkhali and Kutubdia Islands. Shrimp farming was detrimental to the growth and development of mangroves in these islands of the Southeastern Coast of Bangladesh. An environmental concern regarding the mangrove destruction was rising in the society. Social pressure was mounting in favor of restoring the degraded mangroves in the region. That being said, this study was planned to examine the social desirability and economic feasibility of restoring CSB through sylvofishery approaches. Ecosystem services available through existing and proposed land use practices were considered for the study. The benefit-cost analyses showed that benefit-cost ratio of integrated sylvofishery approach became larger than one if environmental benefits of mangrove were considered and integrated mangrove crab cultivation was economically the most feasible practice to restore the area. Sylvofishery was found to be more profitable and sustainable an option compared to existing non-mangrove farming systems. However, the success of such initiative depends largely on strong political commitment of the government and the local leadership.

Email:mahfuzusa@yahoo.com

Methods to prioritize and coordinate forest restoration treatments with sustainable biomass recovery over large landscapes at high resolution

Nathaniel Anderson[1], John Hogland[1], Woodam Chung[2]
1. U.S. Forest Service
2. Oregon State University

The United States Forest Service has developed an object-oriented .NET library of tools for statistical and spatial analysis of natural resources called the RMRS Raster Utility. In this paper we present a case study illustrating a variety of novel statistical and computational techniques and tools that can be used to prioritize restoration treatments and link biomass removals from these treatments to tactical feedstock procurement planning for bioenergy and bioproducts facilities. For a 20,000 km2 procurement area in Montana, USA, we used fixed plot inventory data and 1-meter color infrared imagery to map vegetation characteristics, including trees per acre, basal area, and above ground biomass by species. Then, using parameters associated with fuel treatments to reduce fire risk, we prioritized treatment across the region. Estimates of biomass removals were then linked to road data and regionally specific forest operations and logistics information to produce a facility-specific spatial gate cost model and procurement optimization routine with supply curves. Though we used the RMRS Raster Utility's free, add-in toolbar for ESRI's ArcGIS software, the methods presented can be replicated in almost any GIS environment, and can be applied to diverse, multi-scale spatial inputs to produce useful natural resource mapping, management and planning products.

Email: nathanielmanderson@fs.fed.us

Session F-01 (103): Policies, governance and economics at the intersection between REDD+ and swidden systems in Southeast Asia

The politics of swidden: a case study from Nghe An and Son La in Vietnam

Pham Thu ThuyPham[1], Moira Moeliono[1], Maria Brockhaus[1], Wong Grace[1,2], Le Ngoc DungLe[1]
1. Center for International Forestry Research
2. Center for Southeast Asian Studies Kyoto University

Shifting cultivation, or swidden has long been seen as a major driver of deforestation and degradation. Using two case studies from Vietnam, this paper examines discourses on swidden at multiple levels. Our findings show a disparity between what is perceived as a driver of deforestation in a particular locality, and the proposed measures to reduce deforestation, often focusses only on swidden. Swidden is treated as a political issue, interpreted differently according to different policy preferences and policy translations at different government levels. As a result, swidden is has become 'invisible' as government authorities do not collect and report data on the issue. Since swidden is not recognized 'politically', swiddeners are often 'forgotten' in REDD+ and PES design and implementation. Omission of these actors from forest conservation and management programs could lead to further social marginalization and potentially spillover into deforestation and forest degradation. Our findings suggest that REDD + policies should take into account potentially diverging political interests on controversial land uses such as swidden and consider scientific evidence of ecosystem service provision, such as (but not limited to) carbon sequestration and storage, when assessing the eligible land uses for REDD+.

Email: t.pham@cgiar.org

Mapping a full cycle of swidden cultivation in a Khmu village and its implications for land use stabilization in Laos

ShinyaTakeda
Kyoto University

In this study, we monitored swidden cultivation and forest fallow management in a Khmu village in Laos. Monitoring was conducted between 2005 and 2015 and covered a full swidden cycle. Through GPS mapping, interviews with swidden farmers, and on-site observation, we examined the present state of swidden cultivation in the village. Swidden farming is found throughout the mountains of Laos; however, there is a current preference for the use of other land-use systems. The recent trends toward a market economy have forced the people and forests in the mountains of Laos to undergo various changes as they integrate into the world market. They have been impacted by the enclosure movement called the Land and Forest Allocation Program, the expansion of the cultivation of cash crops such as maize and Para rubber trees, and re-afforestation aimed at industrial wood resources. Here, we discuss the changes taking place in the relationship between the local people and their swidden cultivation system. We also examine the possibility of stabilizing swidden cultivation in the study areas to ensure a future in which the swidden farmers are able to live with a sense of security.

Email: takeda@asafas.kyoto-u.ac.jp

Risk coping strategies of swidden livelihoods in Laos and the potential role of PES or REDD+ incentives

Grace Wong[1,2], Cornelia Hett[3],Tracy Farrell[4],Carl Salk[5,6],Shintia Arwida[1]
1. CIFOR, Indonesia
2. Kyoto University, Japan
3. Center for Development and Environment, Laos
4. Conservation International, Cambodia
5. Swedish University of Agricultural Sciences, Sweden
6. International Institute for Applied Systems Analysis, Austria

This paper examines the risk coping strategies of swidden farmers in Phonxai district of northern Laos, where management of forest and agriculture mosaics is a traditional land use strategy that is well attuned to managing risks. The remaining forests in Lao PDR are largely found in these swidden landscapes where swidden farmers are frequently disadvantaged minority peoples with limited land rights. Misconceptions about swidden are common in Laos – swidden is considered as the major driver of deforestation and forest degradation, and its potential for delivery of ecosystem services over the longer term is largely ignored. As such, policies are in place to restrict swidden, affecting livelihood and landscape sustainability.

We used mixed methods to understand local livelihoods and risk coping strategies. The farmers rely heavily on kinship support and frequently adapt their swidden fields and fallows in response to market signals. We also used field-based games to assess how swidden farmers will respond to forest incentives such as PES or REDD+. The games structure delivery of incentives in the form of individual actions, communal performance and as a form of insurance – mimicking livelihood and coping strategies. The group-oriented incentives provide highest impact in reducing forest use. Results suggest that well-designed incentives can complement forest management within swidden landscapes.

Email: g.wong@cgiar.org

A preliminary assessment of the effect of out-migration on the swidden landscape: a case study in southern Chin State, Myanmar

NyeinChan
University of Forestry

Swidden agriculture, especially in the Southeast Asian region, is rapidly being transformed and is undergoing a transition into other types of land use. One of the significant factors involved in the demise of swidden agriculture is out-migration. This study was conducted in Southern Chin State, Myanmar, to assess the effects of out-migration on the swidden landscape in terms of household income of swiddeners and the biomass of swidden fallow forests. Within the past decade (2003-2013), the number of swidden-cultivating households has decreased by 50% in the studied village, because 20% of the total population has out-migrated for employment opportunities. Consequently, the area of swidden agriculture has decreased. Biomass accumulation in the fallow forests increased from 4.24 Mgha-1 in 1-year-old fallows to 38.65 Mgha-1 in 9-year-old fallows. As the area of fallow forests got increased, total biomass accumulation increased accordingly. Also, despite there being various income-generating sources in the village, remittances from out-migrated family members contribute large amounts to total household incomes. As a preliminary assessment, the out-migration of swiddeners has resulted in the transformation of the swidden landscape from large contributions of remittances to total household incomes and increases in the biomass of swidden fallow forests. This study will contribute to the formulation of a REDD+ program in swidden areas at the local level.

Email: nchan08@gmail.com

Prospects for REDD+ in swidden landscapes

OleMertz[1], Jean-ChristopheCastella[2,3], ThoumthoneVongvisouk[4], NeilDawson[5], Rikke Brandt Broegaard[1], Laura VangRasmussen[6], GuillaumeLestrelin[2,3], SithongThongmanivong[4]
1. University of Copenhagen
2. Institute of Research for Development (IRD)
3. Agricultural Research Centre for International Development (CIRAD)
4. National University of Laos
5. University of East Anglia
6. University of Michigan

The mosaic swidden landscapes with forests, fallows, and fields of northern Laos are undergoing rapid land use change as intensified agriculture and plantations are expanding. This may occur at the expense of older forests, but it is mostly secondary regrowth that is removed and not allowed to grow back to forest. This happens as a response to: 1) land allocation policies that restrict swidden systems to very short fallow cycles; 2) economic policies promoting investment in cash crops and land development; and 3) the uneven enforcement of land policies. We show how contradicting land and economic policies in Laos cause deforestation and forest degradation, with local people as both potential winners and losers. Based on interviews with villages and district, provincial and national level government staff, we argue that successful REDD+ will be difficult to achieve in the current policy environment. Moreover, as local people seize every opportunity to increase their well-being, REDD+ without substantial local payments will not be competitive with other land use activities. A strong focus on the multiple benefits of non-carbon ecosystem services will have to be developed in conjunction with REDD+ to spare the mosaic swidden landscapes that provide these services.

Email: om@ign.ku.dk

Session H-1A (34): Forestry genomics: advances in physiology and genetics

Identification by deep sequencing and profiling of conserved and novel hickory microRNAs involved in the graft process

Qiu Lingling, Chen Xiaomin, Saravana KUMAR KM, Yi Keke, Zheng Bingsong
Nurturing Station for the State Key Laboratory of Subtropical Silviculture, Zhejiang A & F University, Linan, Hangzhou 311300, P. R. China

MicroRNAs(miRNAs) play a vital role in plant development and growth through negative regulation of post-transcriptional gene expression. Carya cathayensis (hickory) is an important species for dried nuts and oil in China, with high nutrition aland economic value. The graft technique is an important strategy for hickory cultivation. To understand the role of miRNAs involved in the hickory graft process, we constructed three small ribonucleic acid (RNA) libraries from hickory rootstock (2years old) and scion (1 year old) at 0, 7, and 14 days post grafting. Sequence analysis of the three libraries identified 21 conserved miRNAs belonging to 13 families, and 10 novel and 8 potentially novel miRNAs belonging to 15 families. Among these miRNAs, 12 miRNAs were differentially expressed during the graft process in hickory and two-thirds were down regulated. Quantitative real-time polymerase chain reaction (qRT-PCR) validated that 14 miRNAs and their expression trends were similar to the results obtained by Solexa sequencing. Further, a total of 89 target genes for conserved and 26 target genes for novel miRNAs were predicted. This study will help in understanding the roles and regulatory modes of miRNAs involvement in the hickory graft process.

Email: bszheng@zafu.edu.cn

Studying the expression pattern of auxin-associated genes in Carya cathayensis (Hickory) during the grafting process

Saravana KUMAR KM[1,2], Qiu Lingling[1], Chen Xiaomin[1,2], Zheng Bingsong[1,2]
1. Nurturing Station for the State Key Laboratory of Subtropical Silviculture, Zhejiang A & F University, Linan, Hangzhou 311300, P. R. China
2. Center for Cultivation of Subtropical Forest Resources (CCSFR), Zhejiang A & F University, Linan, Hangzhou 311300, P. R. China

Auxin role in the grafting process was analysed by studying the differential expression patternof auxin-associated genes (ARF, GH3) and transporter genes (ABC and Aux: Hyd)under auxin- and NPA- (an auxin inhibitor) applied conditions at 0,3,7 and 14days after grafting (dag). Analysis

shows that the expression of GH3, ARF and Aux: Hyd genes were found to be low at the time of grafting but increased at 3and 7 dag and again get reduced at 14 dag. While the expression of ABC gene was found to be high at 14 dag and got reduced at 3 and 7 dag. Further the application of IAA or NPA to the grafted sample is not influencing the gene expression in a concordant way. With the availability of rough draft unigene library for Hickory tree species to our group, 34 different ARF genes were identified and analysed for their expression level at 0, 7 and 14 dag. Among the 23 genes analysed, 15 genes expression level are not affected at various time of analysis and 5 of the genes expression were not detected in the grafted plants. While 3 of the gene expression level got drastically reduced at 7 and14 dag when compared with 0 dag which shows that these ARF genes have specific role in the grafting process which has to be studied in detail in the future.

Email: bszheng@zafu.edu.cn China

Mating system dynamic temporal variation in a coastal Douglas-fir seed orchard

Jiayin Song[1], Blaise Ratcliffe[1], Jaroslav Klápště[2], Yousry A. El-Kassaby[1]
1. Forestry, University of British Columbia, Canada
2. Scion (New Zealand Forest Research Institute Ltd.), New Zealand

As a key component of the tree improvement delivery system, seed orchards play a significant role as the production populations responsible for packaging the genetic gain and diversity captured through breeding. To reach this goal, seed orchards are expected to function as a closed, perfectly random mating population, which, in reality, is rarely fulfilled due to parental fertility variation, reproductive phenology asynchrony, and gene flow (pollen contamination). The actual performance of the mating system within the orchard is thus of primary interest. We studied the mating system dynamic of a second generation, wind-pollinated, coastal Douglas-fir (*Pseudotsuga menziesii var. menziesii*) seed orchard over a four-year period to obtain information under various combinations of seed crop management practices such as supplemental mass pollination (SMP) and/or bloom delay (overhead cooling) and different cone-crop sizes. This study utilized six polymorphic microsatellite (SSR) markers to generate DNA fingerprints of 58 and 489 individuals representing the seed orchard's parental and offspring (2008 seed crop) populations, respectively. The DNA fingerprinting data were used in a likelihood based pedigree reconstruction framework to assign the seed crop parentage using the CERVUS software (Version 3.0) (Kalinowski et al. Mol. Ecol. 2007). The parentage assignment permitted the determination of parental gametic contribution, selfing rate, and the extent of external gene flow. The results obtained from 2008 were compared to the seed orchard's previous performances.

Gametic contribution results indicated that 80% of the seed crop gametes were produced by 64% of the orchard's parents, an estimate that is higher than that observed from the other three studied years (range: 37 – 52%). A 16% selfing rate was estimated, value is similar to what was previously observed (range: 12 – 17%). Finally, external pollen contamination rate of 28% was determined from the total paternal gametes, indicating that the pollen contamination was quite serious in this particular year compared to previous findings (range: 10 – 18%). The observed high pollen contamination rate could result from the lack of crop management practice implementation in 2008 (i.e., no SMP or bloom delay), leading to an extended reproductive phenology developmental period (i.e., lack of enhanced reproductive phenology synchrony) and the absence of pollen augmentation through SMP. On the other hand, the considerable external pollen boosted the outcrossing rate, possibly explaining the observed relatively low selfing rate, specifically when excessive inbreeding was expected due to the extremely low cone-crop size.

This conducted temporal study enabled the comparison of the same seed orchard's performance under different management practices and aimed at providing a guideline for the various seed crop management options implemented and assisting in determining the genetic quality of the orchard's seed crops.

Email: jiayins506@gmail.com

Forest genetics and tree improvement: shift from quantitative genetics to quantitative genomics

Yousry El-Kassaby
University of British Columbia

Advances in single nucleotide polymorphisms (SNPs) fingerprinting made it possible to ascertain, with a great level of accuracy, the actual fraction of alleles shared between individuals, and thus estimates of the realized genomic relationship (a.k.a., G-matrix) among any set of individuals, irrespective of their genealogy, can be determined. This genomic relationship matrix can be used to substitute the classical pedigree-based relationship matrix (i.e., A-matrix) in traditional quantitative genetic analyses. This development represents a clear quantitative genetics watershed as the complete dependency on known pedigree relationships, A-matrix, for estimating genetic parameters can be circumvented and approaches such as "pedigree-free models" became possible. The superiority of the G-matrix resides in its ability to account for: 1) the within-family variation (i.e., Mendelian sampling term), 2) discerning the existence of cryptic family structure within developed pedigree (i.e., full-sib, self-sib, and self-half), 3) the ability to estimate among-family relationships, and 4) identifying pedigree errors if they existed. These advantages, collectively, yield more accurate genetic variance parameters and breeding value estimates, thus permitting better selection decisions. Here, I will demonstrate the advantages of the realized genomic relationship matrix in estimating genetic variance parameters in situations where these estimates have traditionally been impossible using classical pedigree-based quantitative genetics analyses.

Email: y.el-kassaby@ubc.ca

Functional genomics uncovers trait interrelations, pleiotropy, and potential tradeoffs in life-history evolution of forest trees

Ilga Porth
Laval University, Institute for Integrative Systems Biology, 1030 rue de la Médecine, Québec, Canada

Understanding the molecular basis of forest tree growth and development is crucial for the selection of stress resilient trees with enhanced biomass productivity. Knowledge about trait interrelations can help to foresee the expected response to selection for one trait relative to another. Gene-based master regulons that underlie massive extent of phenotypic trait variation and involve multiple traits are termed pleiotropic. When such genes are knocked out, this can have detrimental effects on plant development. Therefore, we employed forward genetics approaches such as Quantitative Trait Locus mapping or genome-wide association studies (GWAS) to discover such genes. In spruce, we identified significant interrelation between the tree's inherent growth rate and constitutive resistance to herbivory. Here, intricate gene interaction networks determining the positive and the negative, respectively, gene-based relationships between growth, development and pest resistance were uncovered. In poplar, we uncovered functional pleiotropy on a gene-by-gene basis by employing GWAS. Genes that associated with different phenotypic traits that themselves are functionally unrelated were considered pleiotropic sensu lato. This is because trait characteristics that are genetically correlated are constraint in their ability to evolve independently. Thus, studying naturally occurring mutations in the natural environment enhanced our understanding regarding genetic pleiotropy in normal gene functions.

Email:ilga.porth@sbf.ulaval.ca

Integrative analysis of metabolome and transcriptome of small and large fruit-bearing Japanese chestnuts during fruit development

Muho Han, Mi Na Choi, Hyo-Ryeon Lee, Eung-Jun Park
Korea Forest Research Institute

Japanese chestnut (*Castanea crenata*) is an important short-income forest species in Korea. Chestnut fruit quality is complex trait determined by various factors such as sugar content and fruit size. To systematically understand the molecular basis of these differences, we compared both metabolomics and transcriptomic profiles in leaf and fruit tissues from cultivated chestnut Daehan (large fruit-bearing variety) and wild chestnut Jangwon (small fruit-bearing variety) during fruit development. We first found that 42 metabolomes in fruit tissues were differentially accumulated between Jangwon and Daehan. Among those metabolomes, the contents of sucrose in Jangwon were significantly higher than those in Daehan during the entire process of fruit development. We also found that sucrose contents were negatively correlated with the fruit size in other chestnut varieties (n=12; pYABBY and WOX1 were overrepresented in the large fruit-bearing variety Daehan. Taken all together, we conclude that both the contents of sucrose and the expression levels of TFs including YABBY and WOX1 might be important factors involved in the determination of chestnut fruit size.

Email: muhohan@korea.kr

Stress-responsive expression analysis of 20 PsnWRKY genes and yeast two hybrid screening to search the PsnWRKY70-interactive proteins in *Populus simonii* × *Populus nigra*

Hui Zhao
NEFU

Populus simonii × *Populus nigra* is a native tree species that distribute widely from the Heilongjiang River to the Yellow River in northern China, and it possesses excellent physiological characters, great ecological potential and considerable commercial importance, is therefore an ideal environment protecting and greening species in the North and Northeast plains. WRKY transcription factors play important roles in regulating biotic and abiotic stress responses in plants. Although a plethora of studies have revealed the functions and mechanisms of some WRKYs in various model plants, the studies of WRKYs in woody plants especially tree species under different abiotic and biotic stress conditions are still not well characterized.

In this study, we selected 20 *P. simonii* × *P. nigra* WRKY genes based on our previous transcriptome study, and characterized these genes by phylogenetic analysis to investigate their evolutionary relations, studied their expression patterns under NaCl, NaHCO3, PEG6000, CdCl2 and *Alternaria alternata* (Fr.) Keissl treatments that mimic the salt, alkalinity, drought, heavy metal and leaf blight fungus infection conditions. The phylogenetic analysis showed that these 20 genes can be divided into five clades (GroupI, IIa, IIb, IIc and III) and almost all of their WRKY domains are conserved. The qRT-PCR analysis indicated that 20/20, 20/20, and 15/20 PsnWRKYs were downregulated under salt, alkali and drought stresses, 14/20 and 19/20 PsnWRKYs were upregulated under heavy metal and leaf blight stresses, respectively. In addition, members from the same clade tended to present similar expression patterns. Most notably is the significant change of the expression of PsnWRKY20 (GenBank accession number of the orthologous Populus trichocarpa WRKY, XP_002323675) in response to salt and pathogen stresses. In consideration of the high homology between PsnWRKY20 (Phytozome, Potri.016G137900.1) and AtWRKY70 (TAIR, AT3G56400.1) protein sequences, the PsnWRKY20 sequence is hereafter renamed “PsnWRKY70”.

In order to further identify the proteins those interact with PsnWRKY70 in salt stress response signaling pathway, 140 mmol/L NaCl solution treated *P. simonii*×*P. nigra* leaves were used as materials to construct a homogeneous pGADT7-DEST yeast two hybrid cDNA library by DSN. PsnWRKY70 gene was sub-cloned to pGBKT7 vector to construct BD-WRKY recombinant plasmid, and then the BD-WRKY plasmid was used as a bait to screen the yeast two hybrid cDNA library of *P. simonii*×*P. nigra*. After twice screening tests and a rotary experiment, five proteins were detected to interact with PsnWRKY70. We analyzed the conserved domains of the five proteins and found that there were two hypothetical proteins (HP1 and HP2, HP1 contains a ClpP domain), one cyclase associated protein (CAP1), one RNA recognition motif-containing family protein (RRM) and one Ulp1 protease family protein (Ulp1) among them. The cis-elements those exist in 2000 bp upstream of the orthologous *Populus trichocarpa* genes of CAP1, HP1, RRM, HP2 and Ulp1 were also analyzed, and the results suggested that the promoter regions of all the five orthologous *P. trichocarpa* genes contained plenty W-box which can specifically bind to WRKY transcription factors. GST-pull down technology was utilized to validate the direct interaction between the complete CAP1/HP1/RRM/HP2/Ulp1 proteins and PsnWRKY70. Equal amount of His-X (X: CAP1/HP1/RRM/HP2/Ulp1) fusion proteins were dropped into normal glutathione agarose resin and GST or GST-WRKY protein-bound glutathione agarose resin respectively, then the interactive proteins were separated by SDS-PAGE. The final Western blot analysis indicated that HP1, RRM and Ulp1 can directly interact with PsnWRKY70 in vitro, while CAP1 or HP2 cannot.

In conclusion, the current study has first identified 20 PsnWRKY genes and explored their expression patterns under salt, alkalinity, drought, heavy metal and fungal infection conditions. Then the yeast two hybrid screening was conducted to excavate the salt responsive interaction partners of PsnWRKY70 protein. The above mentioned results provide valuable clues about the biological functions of the 20 PsnWRKYs in biotic and abiotic stress responses, and indicate the potential stress resistance advantage in PsnWRKY70-transgenic *P. simonii* × *P. nigra*. But these are far from enough, and we are planning to further reveal the functions of some important PsnWRKY genes through genetic transformation, chromatin immunoprecipitation and yeast one-hybrid screening methods in the near future.

Email:zhao_hui_zh@163.com

The complexity of the conifer transcriptome: assembly, expression profiling, and functional examination of mRNA, non-coding RNAs and TEs

Mao Jianfeng
Beijing Forestry University

Conifers possess the most largest biodiversity and make the most wide distribution ranges among gymnosperms. Conifers are dominating many natural and planted forests across the world, their importance for global ecosystem services, their role in accommodation of future clime change and their value for forestry-dependent economies are immense. However we still lag far behind on genetic dissecting of phenotypic variation or even on qualifying/quantifying genomic functional variation, partly due to the extremely large genome size, the genome complexity and life history attributes. Here, we for the first time investigate the coding and non-coding transcripts by the full transcriptome sequencing of a pine species, *Pinus densata*, widely distribute in high mountains of Tibetan Plateau. RNAs from different reproductive and vegetative organs are separately sequenced in ultra-deep depth by Ribosomal RNA (rRNA) depletion protocol. By combining both the de novo and genome-guided assembly, we gain in total 300 thousands unigenes of which 125,000 (92,000 from de novo assembly and 33,000 from genome-guided assembly) unigenes could be aligned to 116,000 loci of the P. taeda draft genome and 54,000 (42,000 from de novo assembly, 12,000 from genome-guided assembly) find significant hits from 51,000 annotated genes from functional annotation of the P. taeda draft genome. We find only 74,000 (24%) assembled unigenes show significant similarity (E-value <= 1e-5) with presenting records in at least one of the five databases: Nr, SwissProt, TRAPID, Pfam and KOG and 21,000 (< 10%) unigenes have significant hits against all of the five databases simultaneously. By robust RNA classification pipeline which combine homologus and computational based predictions, we identify 22 thousands (7%) high-quality coding genes with at least 300 nt length of ORF, 139,000 (46%) unigenes with signals of interspersed TEs and 109,000 (36%) unigenes of high confidence long noncoding RNAs (lncRNAs), while 113,159 (37%) unigenes were predicted to be the precursor of small RNAs and 26 unigenes were housekeeping lncRNAs (tRNAs, rRNAs, snRNAs and snoRNAs). Among the prediction of transcribed TEs, LIR retroelements make up 7% of the whole transcriptome, in which 3% are Copia elements and 3% are Gypsy elements. Non-LIR retroelements contents are few, which is consistent with finding in other conifers. Repeat elements have a 1:1.2 radio of Gypsy to Copia super-family, which is close to 1.2:1 in P. teada. What's more, 7.32% of the transcriptome are uncategorized repeats. The expression are mostly higher for well-supported coding genes than the expression for non-coding genes. And from each different class of unigenes, we find set of genes displaying tissue specific expression. Furthermore, we use Sanger sequencing to verify the assembly and quantitative RT-PCR to validate the expression profiles. Our study provide a deep insight into the complexity of the conifer transcriptome and have remarkable implication for conifer genomics and functional application.

Email: jianfeng.mao@bjfu.edu.cn

The molecular puzzle in regulation of adventitious rooting in poplar

Lu Mengzhu
State Key Lab of Tree Genetics and Breeding, Research Institute of Forestry, Chinese Academy of Forestry

High cost in propagation of seedlings has limited the wide sue of trees in plantations, thus adventitious rooting (AR) is an important trait for trees propagated through cuttings, and. Poplar, for instance, is widely used in clonal plantations, due to its simplicity in propagation through cuttings. Understanding the molecular mechanisms of adventitious rooting in trees is helpful to develop methods to improve the rooting ability of tree cuttings. Here we report several regulators were found involved in the AR of poplar trees, and their effects on AR were accessed through transgenic poplar lines over-expressing their genes. PtFBL1 and PtARF3 as IAA signaling transductor, WUSCHEL (WUS)-related homeobox (WOX11/12a) as meristem identity keeper, and GRF1 as a cell division and differentiation regulator, all contribute to the regulation of AR formation. The interaction of these regulators were further studied in the context of plant hormones and signaling pathways. These results increase our knowledge on the mechanisms of the regulation of AR formation and therefore should be useful for cutting propagation in woody plants.

Email: lumz@caf.ac.cn

Proteomic analysis of stress-related proteins and metabolic pathways in *Picea asperata* somatic embryos during partial desiccation

Jing Danlong[1], Zhang Jianwei[1], Xia Yan[1], Kong Lisheng[2], OuYang Fangqun[1], Zhang Shougong [1], Wang Junhui[1]

1. State Key Laboratory of Forest Genetics and Tree Breeding, Key Laboratory of Tree Breeding and Cultivation of State Forestry Administration, Research Institute of Forestry, Chinese Academy of Forestry

2. Centre for Forest Biology, Department of Biology, University of Victoria

Partial desiccation treatment (PDT) stimulates germination and enhances conversion of conifer somatic embryos. To better understand the mechanisms of the embryos responding to PDT, we employed proteomic and physiological analyses to study changes in somatic embryos during PDT in *P. asperata*. Comparative proteomic analysis revealed that stress-related proteins were mainly involved in osmosis, endogenous hormones, antioxidative proteins, molecular chaperones and defense-related proteins during PDT. Compared with cotyledonary embryos before PDT, these stress-related proteins remained at high levels at 7 days (D7) and 14 days (D14) of PDT. The proteins differentially accumulated in *P. asperata* somatic embryos at PDT D7 could be mapped to be responsible to stress and/or stimulus. They may also involve in glyoxylate cycle and chitin metabolic process. The most significant difference in protein enrichment occurred at metabolic pathways of photosynthesis at PDT D14. Furthermore, in accordance with the changes of stress-related proteins, analyses on changes in water content, abscisic acid (ABA), indole-3-acetic acid (IAA) and H2O2 levels in the embryos indicated that PDT involved in water deficit tolerance and affected endogenous hormones. Our results provide insight clearly into the mechanisms that are responsible for a transition from morphologically matured somatic embryos to physiologically matured ones during the PDT process in *P. Asperata*.

Email:wangjh808@sina.com

Session H-1B (112): Building pathway for sustainable plantation: experiences from Asia–Pacific

Chinese forest plantation: from FMU case study to national sustainable management guidelines

Wang Hong
Institute of Forest Resources Information Technology, Chinese Academy of Forestry

The world largest planted forest of China has failed to meet the goods and environmental services supply of the country, largely for the unsustainable management practices at the forest management unit level. This has been case studied and baseline surveyed by a WWF supported pilot SFM forest plantation research project since December 2015 in 6 state owned forest farms and 3 pulpwood industrial firms in southern China. Problem tree analyses to 49 cases extracted reflect 5 major outstanding problems of SFM at the FMU operational level： (1) Occupation use of public land by local villagers; (2) Poor financial viability partly for little role play of market forces; (3) Weak technological support leading to limited performance; (4) Environmental management not taken as a forest management practice; (5) Internal management short of institutional incentive and modern management mechanism. To promote responsible forest management and in the context of national forestry reform, the study is proposing to forestry authority the "National guidelines for Chinese timber forest plantation sustainable development" by responding to above constraints and referring to related national regulations and international conventions and codes.

Email: wanghong@caf.ac.cn

Session I-01 (28): Application of traditional knowledge for forest management toward sustainable development: exploring the method of participatory approach

Beekeeping and mushroom production in regional contexts of Japan: towards sustainable managements of ecosystem services in socio-ecological landscapes

Ryo Kohsaka, Yuta Uchiyama
Kanazawa University

Beekeeping and mushroom production are implemented as activities of producing Non Timber Forest Product (NTFP) in different parts of Asian region based on regional forest traditional knowledge. These activities including small scale activities support sustainable acknowledgement of ecosystem services, and maintain regional landscapes. In order to understand facts of those activities, interview surveys are required in the sites of activities, because small scale activities cannot be captured by official statistics in Asian region. In addition, accumulation of the knowledge is needed to develop platforms to support the activities by formal and informal manners. In this paper, we provide the results of interview surveys on dynamic aspects of the knowledge for regional beekeeping and mushroom production in Japan. The knowledge has been qualitatively changed over time under the influence of new knowledge provided by new NTFP producers, governments and agricultural cooperatives. If the regional forest traditional knowledge will change to explicit knowledge from tacit knowledge based on regional socio-ecological contexts, the knowledge will continuously be able to contribute to sustainable NTFP production and conservation of forest ecosystems.

Email: yutanu4@gmail.com Japan

A study on the retention of traditional forest-related knowledge: a case of a local community on Yun-Gui plateau

Yinghe Huang, Yeo-Chang Youn
Seoul National University

As a treasury filled with abundant environmental resources that humans rely on for survival and development, forests have been inseparably linked to human well-being. Due to social and economic development, however, the capacity of forests to provide environmental services is being weakened. This poses a question as to whether modern forest science and technologies of resource management is up to the task of maintaining sustainable forest environments. We need to turn to other sources to change the situation and achieve the sustainability of forest environments. Knowledge and practices of local and indigenous communities that have been used to manage forests and utilize forest resources for centuries, without damaging the capacities of forest ecosystems, can enlighten our research for sustainable forest environments. To prevent traditional forest-related knowledge (TFK) from being eroded, previous researches have made great contributions. Nevertheless, there is clearly much that remains undone in many parts of the world. This study aims to understand the status of TFK retained by a local community located in Yun-Gui Plateau – an area in Southwest China where many ethnic minorities inhabited – By utilizing the Vitality Index of Traditional Environmental Knowledge (VITEK), the factors that affect the retention of TFK in the target community are identified. Measures that can potentially revive TFK at the local level are briefly discussed.

Email: lotush924141@gmail.com

Forest management changes and collective actions in a traditional forestry village in southern China

Zhang Minghui, Liu Jinlong, Dai Yao
Renmin University of China

In recent 60 years, under the background of population growth, government continually intervened, ways of livelihood transformed and views of development changed, community-based forest management in Southern China has been changed. Through 4-year anthropological researches in a remote Dong-ethnic village and based on actor-oriented approach for analysis, this paper interpreted how collective actions in the forest management of the village changed and developed in the recent 60 years. This case showed that under the tradition of private management, collective actions were not easy to be formed, but threaten external conditions would more easily trigger agreements on collective actions on the base of long-term community relationship; though compulsive institutions, modern technology, increasing markets or financial subsidies from external, actors would bring pressure on the collaborations, they could not fully change the internal collective actions immediately; however, modernization ideological discourses might slowly change the traditional meanings of forests to similar ends of what modern external actors initiated, and then undermine the traditional collaborative intentions. Hence, it would be the first step for developing a new collective action in the village that exploring traditions to find the collective selves of the village for facing with the unification of modernized challenges.

Email: cathy_minghuizhang@hotmail.com

Forestry traditional knowledge and ecological effectiveness of community-based forestry management: qualitative measurement and analysis

Zhang Minghui, Liu Jinlong, Liu Boya
Renmin University of China

With rapid socio-economy and cultural transformations, forestry traditional knowledge (FTK) in rural community was fading out and mixed with certain extent of modern technical knowledge. Could such hybrid knowledge system have any positive or passive role in community-based forestry management (CBFM) This research figured out this question, through exploring a new qualitative measurement variable, collecting data via focus groups in 8 Dong-ethnic villages and conducting correlation analysis of the relation between the new variable and a quantitative variable of “ratio of natural forestland area to total forestland area”. The new developed variable was called “traditional degree of CBFM”, which was calculated after coding texts of the focus groups so that it could be a quasi-quantitative variable. The correlation analysis showed that higher traditional degree of CBFM was not sure to be significantly related to a better ecological CBFM (higher ratio of natural forest area). That is, such hybrid knowledge system might not be good to the CBFM. This research and its discussion might offer an alternative method for measuring and analyzing the FTK.

Email:cathy_minghuizhang@hotmail.com

Decontextualizing changes of TFRK of Lisu minority in China: a case of Henghe community, Tengchong County of Yunnan Province

Liu Jinlong
Renmin University of China

Change is an eternal topic during the process of human beings development. In this process, though culture is a comparatively steady system, but with the variation of the environment where culture exists, or humans’ attitude towards the environment, culture will also occur to change. Since the opening up and reforming, China’s economic development has a great improvement, as a whole, and the whole society is in a transformation period. This paper taking Henghe community of Lisu ethnic minority at Tengchong County of Yunan province as an example, intended to understand the transformation of traditional forest knowledge and culture against the social and economic development, and government policy intervention with divided 4 phases. These four phases are: 1) the period of slash and burn (from late Qing Dynasty to 1949); 2) the period just before “Land collectivilization” (1963-1984); 3) the period in collectivilization (1963-1984); 4) the period after collectivilization (1985-2010). Transformation of livelihoods, forest management and governances and religious beliefs was deliberated in details. It testified that traditional forest culture has gradually changed in the effect of internal driving force and external intervention, in which, the external intervention including policy intervention and development intervention. Transition, the minority nationality’s traditional forest culture is also having significant change. Researchers have demonstrated that the minority nationality’s traditional forest culture has great importance and meaning to forest resources’ sustainable development and management. Some minority nationality’s traditional forest culture is still existed, and brings positive effect in the management of forest resources. Yet, under the combined influence of globalization, marketing and policy intervention, most of the minority nationality’s traditional forest culture has been flowed away. The change of traditional forest culture is a dynamic process with full of complexity.

Email:liujinlong_jl@hotmail.com

Linking traditional ecological knowledge to adapt climate change in the agroforestry system of the ethnic minority community in southwest China

Yaofeng Luo[1],Liu Jinlong[1]
1. Northwest A&F University
2. Renmin University of China

In the background of global climate change, the corresponding climate and ecosystem change response come about in the southwest China. While, rich traditional knowledge (TK) in the ethnic minority communities in southwest China may provide many opportunities for climate change adaptation. In this paper, we take the Hani ethnic minority community in Yunnan province as case study to investigate how they link agroforestry TK in the terraced fields system to successfully adapt climate change. Our research found out that, the Hani ethnic minority people in the rural community use the rich local TK in the plant diversity, water resource and forestry eco-system management to establish “forest-water-terraced fields-village community” social-ecological system to adapt climate change. The traditional ecological knowledge of the Hani people provide many countermeasures and subtleties for climate change adaptation: Utilization of rich plant resources (medicinal plants and different rice species) to provide enough foods during the extreme climate disaster seasons；Use the traditional water management and regulation system to combat drought；Adopt traditional agroforestry techniques and multi-functional forestry system to provide resilient ability to combat climate change; Properly handle the relationship between forestry, water, terraced field and community to establish the harmonious human-ecological interaction system；Take advantage of the traditional community institutions and village regulations to provide collective action mechanism to adapt climate change.

Email:lyfcl@163.com

Traditional forest-related medicinal plants from Dong community: a case study from Z village

Juanwen Yuan
Guizhou university of Finance and Economics

Dong minority people use different kinds of medicinal plants from the forest, however, the research is still limited and its importance is not attracted. This paper aims to document how do the people utilize the plants in their daily life in Z village. The research methods are participant observation and interviews. The result shows that there are rich medicinal plants in Z village which include brush, grass and arbor. Some are used by their barks, some are by the whole plants. The their function are very diversified and can be used in many kinds of illness. Since western medicine is easier to access to and younger people to migrate, its utilization is decreasing in the village, however, more urban people begin to try to finds ways to use it. This paper suggests that more Chinese medicinal plants from forest should be addressed in local clinic for better understanding and utilization.

Email: yuanjuanwen@qq.com

Session B-02 (20): Valuating the ecosystem services of forests: a gross ecosystem product approach

Valuation of ecosystem services: a critical comparison of approaches with reference to upstream service provider livelihoods

Louis Putzel
Center for International Forestry Research (CIFOR)

Payments for ecosystem services (ES) are an increasingly common mechanism to compensate upstream landholders for landscape restoration providing ecosystem services downstream. Whether subsidized by government or based on market exchanges, valuation of forest ecosystem services is the basis on which payments to upstream landholders or "service providers." Payments based on opportunity costs alone can have serious equity implications. On the other hand, subsidies with poverty alleviation goals may sacrifice efficient delivery of benefits downstream. Use of gross ecosystem product (GEP) as an indicator has promise for understanding the size and total potential value of the market, but in itself does not address trade-offs between downstream ES users and upstream providers. Drawing on insights from a project on "sloping lands in transition" and forest landscape restoration, we provide examples from countries including China, Ethiopia, Nepal to critically explore different approaches to ES valuation, payments and their equity implications. How could use of GEP as a measure be adapted to ensure adequate benefit sharing between upstream and downstream?

Email: l.putzel@cgiar.org

Study of China forest resources accounting

Zhang Zhitao
China National Forestry Economics and Development Research Center, State Forestry Administration

The research of forest resources accounting was put forward to achieve the sustainable development, promote international development trend such as green development, and accelerate the construction of China's ecological civilization to meet the development needs. The research of forest resource accounting can assist to understand the function and value of forest scientifically, objectively and quantitatively. It can also facilitate the shift from resource management to assets management, as well as the construction of ecological civilization institution. Forest resources were analyzed and evaluated from five aspects in China Forest Resources Accounting Theoretical Framework. The woodland and timber resources were accounted in physical terms and monetary terms to reveal the opening and closing stocks and stock changes of woodland and timber resources. Seven indicators of forest ecosystem services were accounted in physical and monetary terms, including the water resource conservation, soil conservation, carbon sequestration and oxygen provision, farmland protection and sand fixation, air purification, forest recreation and biodiversity conservation. This research was derived from the 8th National Forest Inventory (2009-2013). The total value and its changes of woodland and timber assets were accounted, and the accounting results of forest ecosystem services were introduced to provide basis for China Natural Resources Balance Sheet.

Email: daiguangcui@yeah.net

Gross ecosystem product: concept, accounting framework, and case study

Zhiyun Ouyang[1], Chunquan ZHU[2], Yi XIAO[1]
1. China State Key Lab of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences
2. International Union for Conservation of Nature and Nature Resources (IUCN) China

Many countries face the challenge of incorporating ecological performance into political, economic and social decision-making. Current political and economic systems reward GDP growth but do not track impacts on ecosystems. Sustainable development requires fixing this asymmetry and having a system of ecological accounts. Both developed and developing countries are seeking for index and matrix to measure the benefits of human obtained from ecosystem. GEP is a new term proposed based on ecosystem service evaluation, and to account the total value of final products and services provided to human-being by ecosystems, including the value of ecosystem provisioning, regulating, and cultural services. GEP can be used to assess and characterize ecosystem status, evaluate contributions of ecosystems to human welfare, effects of conservation efforts, and quantify the ecological linkages among regions.

Email: ouyangzhiyun2016@yeah.net

Brief Introduction on China's Natural Resource Balance Sheets Compiling Pilot

Faqi Shi
Department of National Accounts, National Bureau of Statistics of China

Compilation of the natural resources balance sheets is a fundamental institutional development to reform the ecological civilization system. The compilation of natural resources balance sheets helps to develop physical accounts of major natural resources such as land resources, timber resources and water resources, which will push forward the establishment of a scientific and standardized statistical survey system of natural resources, help to better understand the real outstanding and changes of natural resources assets in China, and provide information to improve the evaluation and accountability system of ecological civilization performance over resource consumption, environment contamination and ecological benefit. It will also provide information, surveillance and early warning, and decision-making support to effectively protect and sustainably utilize natural resources, and urge ecological civilization and green, low-carbon development.

This paper firstly introduced the background, contents and targets of China's natural resource balance sheets compiling pilot program, which implemented in eight pilot areas, including Huairou District in Beijing Municipality, Ji County in Tianjin Municipality, Hebei Province, Hulunbuir in Inner Mongolia Autonomous Region, Huzhou in Zhejiang Province, Loudi in Hunan Province, Chishui in Guizhou Province and Yan'an in Shaanxi Province. Secondly it described the progress and outcomes of eight pilot areas chosen to compile their natural resource balance sheets in China. Thirdly, it analyzed the main problems facing the pilot areas, lastly proposes the solution to the aforementioned problems.

Email: shifaqi@yeah.net, shifaqi@gj.stats.cn

Session E-02 (10): Evaluating the impacts and enhancing the effectiveness of China's ecosystem restoration programs

The long-term impacts of China's conversion of cropland to forests program: analysis of the influence of household participation intensity and decision-making autonomy on income over a 14-year period.

Michael T Bennett[1], Chen Xie[2], Louis Putzel[3]
1. Forest Trends
2. Forest Economic Development Research Center, State Forestry Administration, China
3. Center for International Forestry Research

This paper utilizes the official monitoring data of the State Forestry Administration of the PRC's Forest Economic Development Research Center (FEDRC) to analyze the impact of the Conversion of Cropland to Forests Program (CCFP) on participant household per capita income. The CCFP is the world's largest afforestation-based Payments for Environmental Services program, having retired and afforested over 24 million ha since its launch in 1999, and involving 32 million rural households. Using FEDRC monitoring data from the four southwestern provinces of Sichuan, Yunnan, Guizhou and Guangxi, this analysis delineates and compares "low intensity" and "high intensity" program participants using propensity score matching to examine differential impacts over a 14-year period. It also introduces newly-collected data on autonomy of program participation choice to examine how this has affected outcomes, as well as to mitigate self-selection bias in estimation results. Representing the most rigorous assessment of the CCFP to date using this dataset, this work finds that program impacts vary significantly throughout the different phases of the CCFP, and that autonomy of household participation choice and level of household participation in off-farm labor markets both have important influences on the degree to which the program benefits high-intensity versus low-intensity participant households.

Email: bennett.michaelt@gmail.com

Assessing the decadal impact of China's Sloping Land Conversion Program on household income under enrollment and earning differentiation

Li Hua, Yao Shunbo
College of Economics & Management, Northwest A&F University, Yangling, China

This study hypothesizes that the income levels of households are affected by their different areas enrolled in the Sloping Land Conversion Program, the local economic condition, and the statuses of their previous earnings. We test these relationships by running quantile regressions with data collected from 182 households in the Loess Plateau region covering the period of 1998–2011. We find that the more cropland was retired, the more subsidy was received, and the more labor was set free from farming, which, in turn, led to a larger decrease in farming income but a much larger gain in off-farm income. Further, the area enrolled had a more positive effect during 1998–2004 than that during 2006–2011 on all households; and the positive effect was significant only on those households of the 0.25thand 0.50th income quantiles later. Also, the proportion of off-farm labor to total labor, the off-farm work time, and the local GDP per capita had a larger income effect in the later sub-period, especially for households in the 0.75thand 0.90th income quantiles. These results carry major implications in terms of how to reduce poverty and increase income in

ecologically fragile regions in and outside of China and how to assess the effect and effectiveness of any ecological conservation program.

Email: lihua7485@163.com

The implementation and impacts of China's largest payment for ecosystem services program as revealed by longitudinal household data

Liu Can, Liu Hao
National Center for Forest Economic and Development Research, State Forestry Administration, Beijing, China

As the largest payment for ecosystem services initiative in the developing world, China's Sloping Land Conversion Program subsidizes households to restore marginal croplands and other degraded fields. While it has attracted broad attention, many questions regarding its performance remain unanswered. Using descriptive and econometric analyses based on a longitudinal dataset containing a large number of surveyed households over 1999-2008, we examine the multi-faceted changes in program enrollment, land and labor allocation, agricultural production, and income structure and inequality. We find that the program has affected land use substantially by simultaneously retiring degraded cropland and increasing forest and vegetation covers, which have accelerated labor transfer into off-farm sectors. Meanwhile, households have intensified agriculture by increasing their production expenditures, enabling them to offset some of the negative effects of the cropland set-aside and reduced farm labor use. While the subsidies have been a significant source of income to the participants, most households have had a larger portion of their income come from non-farming jobs, leading to the increase of average family income by over 250%, and the rural poverty and thus the most vulnerable population have been reduced. As impressive as these changes may be, the program still faces great challenges before the ecosystems are adequately recovered to provide their services.

Email: sfa1sfa1sfa1@163.com

Lessons learned from China on designing and implementing payments for ecosystem service programs

Zhao Minjuan[1], Runsheng Yin Yin[2]
1. College of Economics & Management, Northwest A&F University, Yangling, China
2. Department of Forestry, Michigan State University, East Lansing, MI

Payments for ecosystem services (PES) have attracted broad attention as an incentive-based approach to ecosystem service provision. However, there have been inadequate efforts tackling their design and implementation at the program level. By comparing and contrasting the experiences of restoring degraded cropland in China and the U.S., this paper aims to derive some valuable and timely policy insights that can be used by China and other countries in improving the performances of their PES programs in terms of effectiveness, efficiency, and equity. Building on a well-defined concept of environmental governance and the framework for studying social-ecological systems, our analysis will unfold through addressing several specific questions. They include: What are the socioeconomic and environmental backgrounds for one country to launch a large PES program? How was it designed initially and has evolved over time? How has its performance been evaluated and what are the main outcomes? What are the primary

challenges to its long-term success? Finally, this study calls for a more practical approach to PES design, implementation, and evaluation that will lead to improved outcomes of ecosystem restoration and biodiversity conservation.

Email: minjuan.zhao@nwsuaf.edu.cn

Forest cover and structural changes in northeast China under the NFPP: detection and drivers

Miaoying Shi[1] *Runsheng Yin*[2, 1,*]
1. Department of Forestry, Michigan State University, East Lansing, MI 48824, USA
2. College of Economics and Management, Northwest A&F University, Yangling712100, China

Since the late 1990s, China has been implementing one of the largest ecological restoration initiatives in not only the country but also the world—the Natural Forest Protection Program (NFPP). The overarching questions are how severe the regional deforestation had become before the NFPP was initiated and whether the forest condition in the protected area has significantly improved afterwards, and what are the underlying driving forces of deforestation and the interactions and feedbacks between different land uses. Thus, this study firstly assessed the land use and land cover changes (LULCC) and the interplays between different land uses in northeast China during late 1970s to 2013. It is found that the regional forestland suffered significant and persistent decline, a more than 20% loss, before 2000 when the NFPP was launched; thereafter, however, the forestland became stabilized and forest recovery and agroforestry in the farmland-dominant counties became more prevalent. Further examination based on extended conversion matrixes revealed that forestland was not necessarily the first option to be encroached by farmland expansion; instead, local farmers tended to target other land, especially wetland, first, for farming. During the investigation the effects of various forces driving deforestation, it was found that directly taking farmland as regressor suffer problems, e.g. endogeneity. Thus instrument variables analysis and simultaneous equation modelling were employed to remedy the endogeneity problem and to incorporate the interaction and feedback effects between different land uses. The outcomes of using the instrumental variable method were much improved—the coefficients of NFPP is significant, implying that the program has played a positive role in protecting local forests. Results of the "Forestland-Farmland-Wetland" system confirmed the dominant role of agricultural expansion in forestland loss as well as the importance of considering substitution between forestland and wetland in analyzing the driving forces behind the land use transitions in general and deforestation in particular.

Email: shimiaoy@msu.edu

Session H-2A (30): Sustainable biomass for Asia's growing bioeconomy: regional initiatives and promising examples

Three years of effort towards a regional bioenergy network in the ACMECS countries

Viktor J. Bruckman[1]*, Maliwan Haruthaithanasan*[2]*, Florian Kraxner*[3]*, Raymond Miller*[4]*, Andras Darabant*[5]*, Gnhoung Choumnit*[6]*, Sithong Thongmanivong*[7]*, Memh Ko Ko Gyi*[8]*, Ho Thi Lan Houng9, Warawut Supamitmongkol*[2]

1. Austrian Academy of Sciences (ÖAW), Austria
2. Kasetsart University (KU), Thailand
3. International Institute for Applied Systems Analysis (IIASA), Austria
4. Michigan State University (MSU), USA
5. University of Natural Resources and Life Sciences (BOKU), Austria
6. Ministry of Mines and Energy, Cambodia
7. National University of Laos, Laos
8. Ecosystem Conservation and Community Development Initiative (ECCDI), Myanmar
9. Vietnam Academy of Science and Technology, Vietnam

Global change, including climate change, societal dynamics, economic challenges, environmental protection and the need to improve livelihoods and to reduce poverty have led to a situation where national solutions must be embedded in regional strategies in the ACMECS countries Lao PDR, Cambodia, Myanmar, Thailand and Vietnam. As a consequence of these developments, a regional bioenergy network was initiated under the lead of Kasetsart University (Thailand) with collaborating partners from science, governmental institutions as well as NGO's. The main aims of the proposed network are: (i) To reduce poverty and enhance the livelihood of the rural population, (ii) to protect natural resources and reduce deforestation, degradation and illegal logging, (iii) to ensure a sustainable use of natural resources, with a focus on soils and (iv)to contribute to climate change mitigation by developing a bio-economy. Under this initiative, national bioenergy development plans were developed in a participatory process with the aim to account for national conditions but still under a compatible scheme for a transnational harmonization. The results show that the ACMECS countries are diverse, in terms of potentials for bioenergy crops and their diversity, in terms of the general share of renewables and also in terms of the possible share of biomass in the entire renewable energy potential. This has to be considered and potential synergies can be achieved by linking markets and interests in the entire region. This presentation will present the current status of this initiative, including results of a questionnaire among the involved experts. It will present the roadmap for further integration and development of this regional initiative and potential risks and benefits along the projected further steps will be identified. Further information can be obtained from the recently published IUFRO Occasional Paper Series, Vol. 31, ISBN 978-3-902762-57-3.

Email: viktor.bruckman@oeaw.ac.at

Bird community responses to afforested eucalyptus plantations in the Argentine pampas

David Flaspohler[1], Colin Phifer[1], Jessie Knowlton[1], Chris Webster[1], Julian Licata[2]
1. Michigan Technological University
2. Instituto Nacional de Tecnología Agropecuaria EEA Concordia

Land-use change driven by human population growth and economic activity will continue to impact both natural habitats and land currently devoted to food, fiber, and fuel production.? The effects of land use conversion, whether from natural or cultivated land, on economically important ecological services will depend on how native biodiversity responds to such change.We investigated how agriculture-related land use change influences a breeding bird assemblage in northeastern Argentina by examining common agricultural land uses (1. pasture/annual crops, 2. young and old large-scale eucalyptus plantations, 3. mixed-use farms with citrus and blueberry and 4. small stands of monotypic eucalyptus) and 5. remnant native espinal savannas. In this region, afforested eucalyptus plantations represent a new land-use change from the land cover of pasture and intermixed crops that has dominated the region for over a century. In this mosaic, we

used point counts to assess how bird diversity and community structure differed between land uses.Bird species richness was lowest in older plantations and highest in the espinal savanna, with the other land uses having intermediate richness. Bird abundance trends followed the same pattern, with low overall abundance in the plantations, intermediate levels for pasture/annual crops, and highest abundance in the espinal.Distinct bird community assemblages were strongly associated with each land use, and between young and older eucalyptus. Bird can be useful indicators for biodiversity as a whole, and the depopulated and depauperate avian community within the eucalyptus plantations will likely lead to reduced provisioning of many ecosystem services in this region of the spatial extent of the plantations continues to expand.

Email: djflaspo@mtu.edu

Sustainable biomass production in eucalypt plantations under climate changes: insights from a throughfall exclusion experiment

Jean-Paul Laclau
CIRAD

The frequency of drought periods should increase under climate changes in many tropical regions. A large-scale throughfall exclusion experiment was set up in Brazil to study the interaction between water status and potassium (K) or sodium (Na) availability on the ecophysiology of Eucalyptus trees. Across the water supply regimes, the stemwood biomass at the harvest age was 2.7 and 1.6 times higher in trees fertilized with KCl and NaCl, respectively, than in trees with no K and Na addition. Excluding 1/3 of the rainfall reduced stemwood production only for trees fertilized with K, as a result of low water requirements of K-deficient trees. Gas exchange water used efficiency (WUE) estimates were not correlated with WUE for wood production. The allocation pattern in response to nutrient and water supply appeared to be a major driver of WUE for stemwood production. Phloem sap and leaf ä13C were not valuable proxies of WUE for wood production, which suggests a weak interest for breeding programs. The strong interaction between water and nutrient availabilities on tree functioning in this study suggests that a slight decrease in fertilization rates could help reduce the risks of mortality of Eucalyptus trees under conditions of extreme water deficit.

Email: laclau@cirad.fr

Current Japanese biomass policy and promising local-scale heat and power generation for refueling abandoned urban forest

Toru Terada
University of Tokyo

Japanese government began the Feed-in Tariff (FIT) policy for renewable energies in July 2012 and 272 biomass power plants－3.16 million KW in total capacity－have been approved from November 2015. FIT is expected to contribute to the maintenance of mountainous abandoned forests, but the current rapid increase and emphasis on large-sized, electricity-producing plants threaten domestic biomass supply and biomass heat-energy utilization. In April 2015, FIT policy has been revised to allocate preferential financial treatment to smaller power plants (less than 2MW). This policy changeover provides an opportunity for biomass plants to be set up even in urban areas. The high availability of exhaust heat in smaller plants contributes to the fulfillment of the demand for urban heating. This research aims to estimate the economic feasibility of a Combined Heat and Power (CHP) plant based on the newest FIT policy by having Kashiwa City －a suburban municipality in the Tokyo Metropolitan Area－as a case study. Results show that energy generation by existing woody waste (e.g. demolition waste wood) is not economically feasible, but additional use of wood from urban forest can enhance the feasibility of the plant thanks to added financial value by FIT.

Email: terada21@gmail.com

Towards sustainable biomass energy in east Africa via community forest management

Fikirte Demissie Tulu
Bahir Dar University and EiABC, Addis Ababa University

Wood-based biomass energy is and has been the most important energy sources for hundreds of millions of rural and urban dwellers in all social segments in East Africa. The use of fuel-wood tends to be characterized by poor policies that often follow a top-down approach that promote sustainable management of forest in collaboration with local stakeholders. With respect to fuel-wood production, community-based forest management approaches can successfully expand the supply. Under this management approach, rights and responsibilities associated with sustainable forest management are transferred at the local level. For instance in Ethiopia, the development of current Biomass Energy Strategies (BEST) 2013 should be strongly process orientated with active involvement of all stakeholders at all stages of its development.
The system of community forest management (Participatory Forest Management (PFM)) seeks to initiate the process of eliminating the main causes of forest depletion through participation of local communities. PFM programme has been operational in Ethiopia since 2002 in the forest of Bonga, Chilmo, Borana and Bale Oromiya Region and now in the most part of the country. PFM programme has had positive effect on different aspects of the forests. There is a growing awareness of the importance of forestry and community forest programmes. It has also enhanced households' livelihoods as well as on sustainability of the forest resource. This shows community participation on the management of forest resource may secure sustainable practices which is very crucial to overcome over-utilization of biomass resources that leads to land degradation and deforestation. The main challenges are NGO's phased out from the project result in decrease in forestry activity, less support and protection. However, strong community commitments and bylaws may play role for sustainable use and conservation of forest resources.

Email: fikirkiya@gmail.com

Biomass and carbon storage genetic variation analysis of larch families and provenances

Zhang Hanguo
State Key Laboratory of Tree Genetics and Breeding (Northeast Forestry University)

Based on the 11 provenances of 31-year Changbai larch (Larix olgensis) and 16 families of 32-year hybrid larch as research materials, high-carbon storage families and provenances of have been screened out through measuring indexes of biomass and carbon storage. By SPSS, DPS software analysis, the results showed that: (1) the Baidaoshan and Jixi provenances of L. olgensis in four test sites all grow very well and has good stability and high yielding. The total biomass and carbon storage of Baidaoshan provenance in MaoerShan, Cuohai and Jiagedaqi are ranked among the top three, with carbon storage exceeds total average by 11.11%. (2) In Qingshan, the biomass, carbon storage and timber characteristics heritability of 16 hybrid families are measured relatively higher while the carbon content rate is lower; the heritability of total biomass, total carbon family are 0.579, 0.581 respectively. Under 20% selection rate, genetic gain of the total biomass and total carbon storage are 27.29% and 29.91% respectively . According to the genetic variation and correlation, three good-growth and highly carbon sequestration hybrid larch families arefinally screen out，the carbon-storage of these three top families are 14.13% more than the average.

Email: hanguozhang1@sina.com

Session H-2B: Research status and technical breakthrough of bio-based (wood or bamboo) scrimber

Research status and technical breakthrough of bamboo (or Wood) scrimber in China

Wenji Yu, Yanglun Yu, Rongxian Zhu, Yahui Zhang, Dinghua Ren, Yamei Zhang, Yue Qi
Research Institute of Wood Industry, Chinese Academy of Forestry

The paper reviewed the history of the bio-based scrimber such as bamboo scrimber and wood scrimber industry including technology, processing, continuously manufacturing equipments and standardization. Bamboo scrimber, which is manufactured by using mechanical treatment without any chemical and moving the inner and outer layers of the bamboo, has great potential application as engineering materials due to its highly manufacturing efficiency, utilization and good mechanical properties. The innovativemanufacturing technology of thewoodscrimber was also developed. The basic unit of the novel wood scrimber was obtained by peeling wood into veneers first, which was different from the traditional one of wood bundles. The novel bio-basedscrimbermanufacturing technics provided a feasible technical solution for high performance scrimber products from bamboo and plantation wood. It can be used for flooring, furniture, building, and other civil engineering applications. Currently, there existsapproximately 80 bamboo scrimber manufacturing enterprises in China with an annual capability of 600,000 m^3.

Email: yuwenji@caf.ac.cn

Application of high performance wood scrimber in building windows and doors

HaitaoLi[1],Qingling Shi[1], Ping Wu[1], YahuiZhang[2]
1. Shandong Chambroad Wooden Base Material Co., Ltd.
2. Research Institute of Wood Industry，Chinese Academy of Forestry

The high-performance wood scrimber was produced from small-sized fast-growing wood material with the new process techniques of peeling the wood into thick veneer and impressafining, which has characteristics of high-strength, large-section, and natural timber grain. In the poplar scrimber density of 0.90 g/cm^3, the experimental results showed that MOR and MOE were 133MPa and 17549MPa, respectively, and the thickness swelling rate was 8.34% after 28h “boiling-dry-boiling” cycle accelerated aging tests, while the formaldehyde emission was 0.1 mg/L. The properties of painted samples were also satisfied the requirement of the national standard for wood doors and

windows. Furthermore, Shandong Chambroad Wooden Base Material Co., Ltd. have developed window products which produced from high-performance wood scrimber.Under the testing of scrimber products, it is showed that K value is 1.2W/(㎡.k), combustion performance is up to GB8624B1 (C-s1, d0, t2) level. The obtained results are encouraging that the scrimber could be used for manufacturing windows and doors.

Email: zhangyahui@caf.ac.cn

Development of phenolic resin for bamboo (or wood) scrimber

Guomin Bian
Dynea Guangdong Co., Ltd.

To improve the impregnation and curing properties of the PF resin, this study investigated that the F/P molar ratio and additives were used to develop the phenolic resin. The results showed that the final contact angle of phenolic resin in bamboo was 40 °which was 1/2of the old one, and Mn 485 was 1/3 of the traditional phenolic resin. The enthalpy of resin was 344.8 J / g, and the enthalpy value is 298.3 J / g after 70℃ drying. The activity of resin is retained to 86.5%, thus the index can be satisfied with the requirements for technology. The performance data of the scrimber material produced with PF above have meet requirements for outdoor products. For the produced bamboo scrimber samples, the MOR was 364MPa, MOE was 32400MPa,the thickness swelling rate was 2.80% after 28h “boiling-dry-boiling” cycle accelerated aging tests, and the formaldehyde emission was 0.1 mg/L, respectively.

Email: guomin.bian@dynea.com

Study on key manufacturing technology of heterochromatic recombined bamboo lumber for decorative use

Yuhe Chen, Sheng He, Zaixing Wu, Neng Li, Jingpeng Li
China National Bamboo Research Center

Being fast growing, renewable, sustainable and versatile use, bamboo has attracted more attention, however, the relatively dull color and grain limit the application of bamboo for decorative use. Some key manufacturing technology including preparation of flexible bamboo unit for modification, color modification of bamboo unit, heterochromatic recombination of modified bamboo units and improvement on properties of light-resistant aging and water-resistantwere studied. Briefly speaking, a new machine were developed to produce bamboo unit that flexible and easy to modify, high permeable dyeing solution were configured and dyeing parameters were opitimized, with different color bamboo units and special machines, heterochromatic recombined bamboo lumber were developed, and water repellent, organic UV radiation-absorbing coatings with barrier properties for use on the recombined bamboo lumber surface were applied to enhance its durability. The results showed that the heterochromatic recombined bamboo lumber has a beautiful and stable color and diverse grain, and the coatings provided a high degree of shielding from UV radiation and water, therefore, this new bamboo lumber is suitable for decorative use.

Email: yuhec@sina.com

The manufacturing equipments of the high performance bamboo (or wood) scrimber

Guojun Mu[1], Jing Sun[1], Yan Li[1], Fengyou Cao[1], Yanglun Yu[2]
1. Qingdao GUOSEN Machinery Co.,Ltd.
2. Research Institute of Wood Industry，Chinese Academy of Forestry

This study reviewed the historic development of manufacturing equipments for the high performance bamboo or wood scrimber such as thick veneer peering lathe, bamboo or wood fluffing machine, cold-press machine, cold-press mold, special curing kiln, multilayer hot-press with water cooling system, and hot-press mold with movable stop lever, which were applied into two kinds of forming processes including cold molding-hot curing, and hot-pressing.

Email: yuyanglun@caf.ac.cn

Application and research on si-al gel/wood composites

Yongqun Xie, Jinghong Liu, Biaorong Zhuang, Qinping Zhuang, Tingjie Chen, Zhenzeng Wu
Fujian Agriculture and Forestry University

Silica-alumina sol (Si-Al) with Si/Al molar ratio of1:1wassynthesized by sodium hydroxide and Aluminum hydroxideand sodium silicatesolution as the processing of artificial zeolite. A 110 nm thickness Si-Al inorganic film with many mesopores ranging from 10 to 50 nm was obtained on the surface of fibers, when they uniformly mixed with wood fibers. Wood fibers with Si-Al inorganic film have a good thermostability and antimicrobial properties.They can be used to manufacture flame-resistant and mildewproof wood composites. Under these conditions, the physical properties of middle density fiberboard (MDF) with B1 flame retardant grade could meet national standards. And the outdoor recombinant bamboo with light color has a good mouldproof functionwhich 30 days mould is less than 1 grade.Also, wood fibers processing by Si-Al solcan be used to produce formaldehyde-free and environmentally friendly artificial board with unsaturated polyester resin. When the amount of unsaturated polyester resin was 4%, the physical and mechanical properties of boards could meet national standards. Additionally, Si-Al sol could be used to synthesize inorganic adhesive. The physical and mechanical properties of MDF and chipboards with 8% inorganic adhesive could meet national standards. And their productionprocess is the similar to urea-formaldehydeadhesive.

Email: fjxieyq@hotmail.com

Measuring and evaluating of bamboo scrimber carbon footprint

Wenji Yu, YanglunYu, Rongxian Zhu, YahuiZhang, Dinghua Ren, YameiZhang, Yue Qi
Research Institute of Wood Industry，Chinese Academy of Forestry

A bamboo scrimber is a novel engineering composite prepared from parallel bamboo bundles with adesirable texture, high hardness, and longitudinal strength properties. It can be used for flooring, furniture, building, and other civil engineering applications.To quantify the manufacture of bamboo scrimber carbon footprint, an British Standards Institution BSI "PAS2050" requirement was used to track and collect BTB (Enterprise - Enterprise) primary activity data for all chains of emission sources (including transportation, manufacturing, distribution and raw material appendages). The results showed that the bamboo scrimber is a negative carbon product: the carbon emissions of 1m^3 bamboo scrimber in the whole manufacturing process is 304.69 kg; and the carbon reserves of 1m^3 bamboo scrimber is 348.33kg; therefore, 1m^3 bamboo scrimber is produced with its carbon footprint of -43.69 kg.

Email: yuyanglun@caf.ac.cn

An application of thermo-hygro mechanical densification on engineered wood flooring for heavy-duty use

Chang-Hua Fang[1], Alain Cloutier[2], Pierre Blanchet[2], Costel Barbuta[3], Ben-Hua Fei[1]
1. International Center for Bamboo and Rattan, State Forestry Administration of China, Beijing, China;
2. Département des Sciences du Bois et de la Forêt, Université Laval, Québec, QC, Canada;
3. FPInnovations, Québec, QC,Canada

High density wood is required for wood flooring, especially for engineered wood flooring for heavy-duty use, as most mechanical properties of wood are correlated to its density. However, high density wood resources are limited and at a high cost. Densification treatment makes it possible for low or moderate density woods to be substituted for harder species such that low or moderate-density wood species can be modified into high performance and high value products, such as engineered wood flooring for heavy duty use. The objectives of this study were to develop suitable densification processes for thin lumber of sugar maple and red oak, and develop a new type of engineered wood flooring with high surface hardness and good dimensional stability. This study was performed based on our previous work. The densification process was improved for the wood species used for wood flooring. From the results of this study, we can conclude that thin sugar maple lumber densified at 200°C under the effect of steam, heat and pressure showed good potential for the manufacture of engineered wood flooring for heavy-duty use due to its high density and improved mechanical properties, as well as relatively high dimensional stability and an attractive color. The densification of thin red oak lumber appeared to be difficult due to blisters developing on the surface during the process.

Session I-02 (39): The role of urban forests in improving air quality

Plant species differed in particulate matter reaccumulate ability

Chen Guojian
Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences

Airborne particulate matter (PM) removal is a major component of ecosystem services provide by urban green infrastructure, selecting the optimal species for urban greening could maximize PM removal services. We evaluated PM reaccumulate ability of ten speices by quantitative leaf surface PM after one day and twenty-one days of a rain according rinse, filter and weigh method. Some species had substantial surface PM just after the rain, although it didn’t had large effect on total PM reaccumulate ability, fine and coarse PM reaccumulate capacity were badly affected. PM reaccumulate efficiency was lower on pine and higher on species with high self-cleaning ability, higher on large PM and lower on fine PM. Species differed in PM reaccumulate ability and efficiency, fine and coarse PM reaccumulate ability are highly differed from maximize accumulate ability, selecting species for fine and coarse PM mitigation should be quite careful.

Email: pavonina@163.com

The urban forest and the air quality

Carlo Calfapietra, Elena Paoletti
CNR

Urban forests provide a number of benefits to the urban environment and consequently to human health and well-being. Trees in the city contribute to the improvement of the environmental conditions because of their multiple mitigation effects and their ecological properties. Trees can either influence the microclimate, reducing the heat island effect in the summer and preventing an excessive cooling in the winter. Trees can help achieving the commitments of CO2 reduction through both direct uptake and indirect save of energy related to the microclimate effects. Trees in the city can absorb soil and air pollutants making the environments where most of people live more healthy. A number of studies have assessed the effects of air pollution on urban trees while others have focused on their role in mitigating air pollution. This interaction is sometimes very complicated because the effect of air pollution can limit the capacity of plants to absorb the pollutant itself.

Moreover some trees emit biogenic volatile organic compounds (BVOCs) which can favor the formation of photochemical pollutants such as ozone.

Besides presenting data collected at different levels, i.e. in laboratory conditions, at ecosystem scale and with a modeling approach, we speculate on strengths and weaknesses of the different approaches and on the implications of similar results for both the planning and the management of the urban forests.

Email: carlo.calfapietra@ibaf.cnr.it

Capture effect of PM10 and PM2.5 by twenty-one landscape trees in Beijing

Pengwei Bao
School of Soil and Water Conservation

Particulate pollution in Beijing, especially the inhalable particulate matter (PM10) and fine particulate matter (PM2.5) have adverse effects on human health exacerbating a wide range of respiratory and vascular illnesses. In order to study the capture effect and capture process of PM10 and PM2.5, twenty-one different tree species were placed in an indoor simulative box of 1 cubic meter, with the condition of static wind, constant temperature and humidity. The particles were generated by aerosol generator and we set the controlled experiment and then monitored the dynamics of particulate matter mass concentration. Here we present accumulative capture amount, time limit for capturing particles, capture rate, capture amount of unit leaf area and capture efficiencies of these twenty-one species widely used in urban landscape construction. These data of the species of trees are not involved in previous study, the experiment was conducted under an ideal condition and the data was measured in high precision. The results show as follows:

1.The capture process of all species were basically the same. The accumulative capture amount of particulate matter captured by twenty-one plant species is generally consistent with time, it increased rapidly at first, then gradually slowed down, and finally leveled off and stabilized. Bungeana (*Pinus bungeana*) has shortest saturated absorption time of PM10 and PM2.5, with 18 hours and 22 hours, repectively. Euonymus (*Buxus megistophylla*) has longest saturated absorption time of PM10 and PM2.5, which are 36 hours and 45 hours, respectively.

2.The capture capacity is significantly different between the twenty-one plant species. Syringa reticulate has the strongest PM10 capture capacity, which is 1.976μg PM10 per square centimeter, while Cedrus deodara has the strongest adsorption capacity of PM2.5, with a value of 0.887μg per square centimeter. *Buxus megistophylla* has the weakest capture capacity of PM10 and PM2.5, which is 0.318μg and 0.165μg per square centimeter, respectively.

3.The PM is mainly captured in the leaf surface and wax coat. Around 54.9%-63.7% particle matter is adsorbed on the leaf surface. We use the density of the particles to represent the capacity of absorbing large particles (diameter of 10-100 μm). *Syringa reticulata* has the highest accumulation capacity (1.997 $\mu g \cdot cm^{-2}$) and *Buxus sinica* has the lowest PM accumulation (0.425 $\mu g \cdot cm^{-2}$). For coarse particles (2.5-10 μm), Syringa reticulate adsorb 1.225 μg per square centimeter, which is 5 times of *Buxus sinica*. For the particle with the size of 0.2-2.5 μm, there is no significant different between twenty-one plant species on PM accumulation capacity. *Koelreuteria paniculata* and *Pinus bungeana* have the highest PM accumulation (0.854 $\mu g \cdot cm^{-2}$and 0.850 $\mu g \cdot cm^{-2}$). The particle density of the leaf surface is close to that of the wax layer.

Email: 598415186@qq.com

Particulate matter on the foliage of urban vegetation: size, shape and spatial distribution characteristic

Lin Lin[1,2], Ma Keming[1], Yan Jingli[1,2]
1. State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences
2. University of Chinese Academy of Sciences

Plant can migrate ambient particulate matters, playing the role of cleaning the air. Here, we present a novel approach that can not only accurately quantify the number of particles, their size and shape, but also the spatial distribution characteristic of particles of different diameters on the leaf , that is proximity. We sampled three common board leaf species and 25 scanning electron microscope pictures were taken from five leaves for each species. Our use of remote sensing method achieved the identification of the particulate matter from the pictures. Then, Fragstats was employed to analyze the landscape pattern of leaf surface particles. Our result showed that , *Saliz matsudana* was more efficient than *Ailanthus altissima* and *Fraxinus chinensis* in terms of the number and area of particles per unit area and the proportion of fine particulate matter. We demonstrate that the particles on *Saliz matsudana* and the *Ailanthus altissima* respectively have the highest and lowest proximity among the three species. PM1 in *Ailanthus altissima*, PM10 in *Fraxinus chinensis* and *Saliz matsudana* have the highest proximity, which may further influence the following process of dust retention.

Email: 3466250088@163.com

A stomatal ozone flux-response relationship for five poplar clones widely planted in China

Feng Zhaozhong, Hu Enzhu, Gao Feng
Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences

To assess regional effects of ozone (O3) on poplar species whose planting area in China ranks first in the world, we developed a flux-based dose-response function for poplar. In this study, five poplar species (*Populus alba* × *Populus glandulosa*, *Populus* × *euramericana* cv. '74/76', *Populus deltoides* × *Populus cathayana* cl. 'Senhai 2', *Populus deltoides* cl. '55/56' × *Populus deltoides* cv. 'Imperial', *Populus deltoides* × *Populus cathayana* cl. '156') widely planted in Northern China were exposed to O3 concentrations ranging from around 48.2 ppb (6:00-18:00) in the non-filtered air treatment up to 69.1 ppb (6:00-18:00) in the fumigated treatments. Measurements of stomatal conductance (gs) on these five poplar species were used to calibrate a Jarvis-type multiplicative gs model. The maximum gs as well as other model parameters varied between species. The model includes functions describing the reduction of gs of senescing leaves and the direct effects on gs by light, temperature and water vapor pressure deficit. Comparison between simulated and observed gs for the five poplar species resulted in an R2 value at 0.55. The calibrated gs model was used to estimate the accumulated stomatal flux of O3 above the threshold value. The strongest relationships between relative O3 effects on aboveground biomass and total biomass were obtained when POD was integrated using an uptake rate threshold of 8 nmol m-2 s-1 (POD8) with an R2 value of 0.89 over all five poplar species. The R2 value was close to that for the corresponding relationship based on the accumulated ozone exposure over 40 ppb (AOT40; R2 value of 0.86 and 0.89 for aboveground biomass and total biomass, respectively).

Email: fzz@rcees.ac.cn

Session A-03 (76): Implications of the Paris Climate Change Agreement (CoP21) on Forests, Water and Soils

Implications of Paris Agreement on forests water and soils

Wang Chunfeng
Department of International Cooperation, State Forestry Administration, China

This oral presentation will introduce the essential elements on the Paris Agreement and the updated status of ratification of the agreement. Based on the latest analysis of the actions in the Intended Nationally Determined Contributions (INDCs) submitted by the Parties to the Convention, both potential positive and negative implications of the Paris Agreement on forests, water and soil are initially analyzed against the key conclusions from the impacts assessment of WGⅡ IPCC AR5.

Email: wangchunfeng@forestry.gov.cn

Forest adaptation and restoration go along with soil conservation and climate change mitigation

Andreas Bolte
Thünen Institute of Forest Ecosystems, Germany

Forests landscapes can play an important role for (1) climate change mitigation due to CO2 sequestration in long-living biomass and timber products as well as in forest soils and (2) soil conservation and protection through an extensive management and a low soil disturbance regime.

However, these functions are impaired or even threatened by both environmental and societal pressures.

Along with climate change, extreme weather events leading to e.g. drought and fire may become more frequent and powerful and as such challenge forest stability and resilience at a scale and with rapidity seldom experienced in the past. Additionally, problems caused by novel pests and diseases as well as new problems with current agents such as ungulates or diseases and invasive species and pests as they are affected by changed climate are likely to arise. At the same time, societal demands on land use including forestry are changing. Rising world population in tandem with higher incomes and changing human food preferences leading to increased demands for meat and dairy products cascading into forest degradation or even deforestation in order to attain more crop and graze land in many parts of the world. Rising demand for bioenergy may put higher pressure on forests by increased harvests of wood and biomass.

These challenges necessitate research and knowledge transfer about Adaptive Measures (AM) for forest landscapes that includes Adaptive Forest Management (AFM) on stand scale and Forest Landscape Restoration (FLR) activities at the landscape scale. Within the IUFRO Task Force Forest Adaptation and Restoration under Global Change we thus work on (1) identifying knowledge gaps in the adaptive potentials of tree species/provenances under climate change, (2) comparing existing activities and techniques of AFM and FLR in different climatic zones and continents as well as (3) evaluating the success of AFM and FLR measures and present best practise approaches for those concepts. Forest ecosystem services like soil protection and mitigation options are important criteria for the evaluation. This is done for different world regions aiming at making information and knowledge about AM available for stakeholder and the public using web-based surveys, databases and online information systems.

Challenges in effectively integrating forests in the Paris Agreement

Professor Rod Keenan
University of Melbourne

The Paris Agreement on climate change at COP21 is a major landmark in climate policy, providing a comprehensive and inclusive framework for action with ambitious long-term targets to avoid dangerous anthropogenic global warming. Over 60 countries made reference to REDD+ in their Intended Nationally Determined Contributions and, as part of the Lima Paris Action Agenda, heads of government from major forest countries and partners committed to action prior to the COP meeting to promote equitable rural development, reverse deforestation and massively increase forest restoration.

The rate of forest loss is declining in some countries, most notably and encouragingly in Brazil, but rates of forest loss remain high or are increasing elsewhere in the world.

This presentation reviews some of the key challenges for effective integration of forests related measures into the Paris Agreement objectives. This is includes investment in monitoring for scientifically robust emission baselines against which countries can demonstrate future emission reductions, finance, poverty alleviation and integration with recently agreed Sustainable Development Goals.

Forests are still seen by some as a relatively cheap and easy way to reduce greenhouse gas emissions. The reality is much more challenging. There have been relatively limited results from nearly half a century of international efforts to reduce tropical forest loss. Addressing poverty, resolving land tenure and forest ownership, increased demand for land for agricultural production, poor coordination between different levels of government and infighting and differing objectives between government agencies are major impediments to reducing deforestation and restoring forests. Effective forest-based measures to meet the Paris objectives will need strongly supported and coordinated policy frameworks and solutions that mobilise and meet the needs of local actors across multiple-use landscapes.

Reforestation of dryland farming systems: potential and challenges

Stanley J. Sochacki
Murdoch University, Australia

A key outcome of the 21st Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change (UNFCCC) in Paris, was the recognition by a large number of countries of the importance of forests for meeting carbon mitigation targets. The Paris Agreement sends a strong political signal as to the importance of forest protection, management and restoration, with the implication that forest mitigation activities will also address environmental degradation as a result of unsustainable agricultural practices.

In Australia the deforestation of 100 Mha of natural forests in low rainfall regions for the establishment of farmland has resulted in extensive ecosystem degradation including dryland salinity, wind erosion and degradation of wetland ecosystems. For example, considerable areas of farmland and major water resource catchments have been affected by salinity. As part of the implementation of the Kyoto Protocol considerable work has been done with the dual aims of achieving carbon mitigation and also more productive and sustainable farming systems. This included the development of new ways of integrating forestry into farming systems, the selection of new species, new carbon inventory systems, the valuation of co-benefits and new policy instruments to allow investment in carbon projects. Investigation occurred at a range of scales and included new methods to measure below ground biomass carbon, which is an often overlooked carbon pool. There is now an active carbon forestry industry.

The ability to quantify mitigation will be a challenge, but the learnings from the suite of Australian activities are applicable to potential forest carbon mitigation projects in other countries.

REDD+ Program in Vietnam: A win-win solution for the Paris Agreement

Hai Nguyen Thi
Vietnamese Academy of Forestry Sciences

Vietnam is among the top five most vulnerable countries to the adverse effects of climate change. In response, Vietnam has formulated a number of policies to address both adaptation to climate change and mitigation of GHG emissions, including commitment to REDD+. In the INDC of Vietnam, REDD+ is considered a potential contribution. However, there are still challenges in implementing REDD+ in Vietnam such as financial sources, stakeholder participation, the development of an MRV system which needs the national efforts and international support.

The new Paris Agreement adopted at COP21 sent a strong, unprecedented message that REDD+ is a critical and prominent piece of the new global climate goal to achieve net-zero emissions in the second half of this century. This announcement is expected to bring great opportunities to implement REDD+ in developing countries, including Vietnam. It can say that, there is a close link between the success of REDD+ and the achievement of Paris Agreement.

This paper will present the possible contribution of REDD+ Program in Vietnam to implement Paris Agreement, potential issues that require resolution and the opportunities of the Program after the Paris Agreement.

Use of forest resources in an experimental forest farm in Poland

Piotr Paschalis Jakubowicz
Warsaw University of Life Sciences

One of the consequences of the Paris Climate Agreement has been the development in Poland of a project testing innovative solutions in the management of forest carbon farms. The program of experimental forest carbon farms will be implemented predominantly in existing promotional forest complexes (with a total area of 1.2 million ha). Tests will cover, among others, introduced, selected tree species that allow for an increase in carbon sequestration by approx. 10%, the introduction of an additional layer in the stand structure, the application of other types of harvesting and the adoption of different harvesting ages. Forest management in forest carbon farms will differ from the current sustainable forest management. This applies also to proposed solutions in the use of forest resources.

The experimental project presented in the paper and an analysis of initial results of works relating to the deployment of a forest carbon farm into forest practice point to the necessity to apply unprecedented solutions in the management of forest areas that allow for the stimulation of carbon dioxide sequestration with a simultaneous promotion of biodiversity and intensification of wood production.

All experimental forest areas will come under a 10-year program of the so-called additional actions in forestry, including the monitoring of natural wealth and the monitoring of changes in water management.

Email: Piotr.Paschalis@wl.sggw.pl

Session B-03 (115): Promoting small holders forest plantation management in a sustainable way

A win-win solution: supporting small holder to develop forest management and secured board producer's raw material sourcing

Mr Qiang Zhang
Dongying Zhenghe

In order to secure Dongying Zhenghe's raw material procurement, Zhenghe working with suppliers and forest farmers closely with the coordination from local forestry bureau. With the positive cooperation with multiple stakeholders, forest farmers' income increased and secured.

Also Zhenghe is satisfied for raw materials' procurement is secured. It's win-win situation for both board producer and small holders.

At the beginning of 2015 with the support from WWF Chinese Academic of Forestry and IKEA, Zhenghe started certification in Changle County. There are 439 villages joined FSC group certification. Each village join as a certification sub-group on behalf of the forest owners. Zhenghe signed contracts with all villages and villages signed contracts with each forest owners. With FSC group certification local environment is improving, logging workers' safety awareness also improved. Small holders start aware of sustainable forest management with professional guide from forestry expert with serval rounds training. Organizer support small holders to purchase fertilizer and pesticides, integrated transportation and trade. Small holders may combined applying cutting license and transportation license as well. All these activities saved small holders' time energy and money which motivated them to join certification and sustainable planting poplar in a sustainable way. This also supports Zhenghe's forest board integration it's a win-win solution.

Email: zhq2787@vip.163.com

The Company cooperates with Cooperatives
to promote sustainable plantation management by small farmers

Su Changyong
Robina

The problem for sustainable plantation management by small farmers has been the focus followed with interest by forestry expert, which is also the problem needed to solve urgently in China plantation development. It is very complex.

Robina Limited is one wood processing enterprise which produce MDF/HDF (Medium Density Fiberboard/High Density Fiberboard). Robina takes the cooperatives as link to cooperate with small farmers offer fast-growing seedlings and provides technical instruction to help small farmers to plant and develop forest resources for many years. At the end of Year 2014, the Company took forest certification as starting point and helped cooperatives to establish a new system to work out forest management plan and organize trainings for several times. Afterwards Cooperatives members' consciousness regarding forest sustainable management have been increased a lot. When passed certification Robina increased procurement price for certified wood and bring the market orientation into full play as well as bring visible and tangible benefit to small farmers, to ensure the Cooperatives continue to execute in strict accordance with FSC standards, this motivates small farmers to promote sustainable plantation management.

Email: resource@robina.com.cn

Forestry group certification: Promoting sustainable forest management

Fengchao Fang
Guangxi Sunway

With supports and guides from IKEA WWF Chinese Academy of Forestry(CAF) as well as Wuzhou Forestry Bureau and Cangwu Forestry Bureau, Guangxi Sunway Forest Products Industry Co., Ltd developed forestry group certification since July of 2014. The certification members including: Guangxi Wuzhou Foresource Sunway Forestry Co., Ltd, Cangwu County Kangyuan Forest Farm, Cangwu County Fuyuan Forest Farm and small farmers from local villages of Cangwu County which includes 28 villages around 5,000 households. The certification area is nearly 300,000 ha, main species are Chinese red pine, eucalyptus, Chestnut oak Schima and so on. Sunway got FSC certificate on 2nd June, 2015 and passed 1st year surveillance audit in April 2016. The certified forest can supply 100,000 tons certificated raw wood and 60,000m3 certificated MDF each year.

60% certificated wood is from small farmer's forest, compare to non-FSC wood, Sunway promise to raise maximum RMB30/ton for the certificated wood since March 16, 2016. Based on this, small holders may increase by 1,800,000 RMB in their income, average 360 RMB for one household. Sunway also supports small farmers to apply cutting license and transportation license to reduce farmer burden especially reduce travel difficulties for the elder people.

Improvement of economic efficiency can reduce farmer's reliability on eucalyptus plantation and add up proportion of tree species, increase the biological diversity. It supports small farmers to have a better understanding of "clean village, beautiful Guangxi" via certification, Promote everyone to build a beautiful environment and new rural areas of ecological harmony in order to increase farmers' consciousness of occupational health and safety Sunway provides continuous training and communication and PPE (People's protection equipment) to related workers for reducing injury risk.

Email: swffc@126.com

Bamboo forest sustainble management

Li Bing
Fujian Longtai

Bamboo forest is a very import forest type in South China and also the most important sources of income for farmers who live in rural areas. Fujian Longtai is a leader by turning bamboo poles into products e.g. kitchenware and garden products and plays a very important role in local revenue and provides jobs for local farmers. As they have main customers in Europe, Longtai starts FSC certification on their own forest lease 193 ha in 2013 and then extend the area into 3020 ha by group another 2 villages and 2 forest farms in 2016. By working with FSC certification, they improved the management of bamboo forest and also trained local people to understand sustainable forest management.

Email: jclian@vip.163.com

Session C-03 (51) : Air pollution and climate change impacts on forest ecosystems

Acclimation of northern forest trees to rapidly changing environment - insights from the Betula studies

Elina Oksanen[1], Kaisa Heimonen[1], Keinänen Markku[1], Keski-Saari Sarita[1], Kontunen-Soppela Sari[1], Lihavainen Jenna[1], Tenkanen Antti[1], Rousi Matti[2]
1. University of Eastern Finland
2. Natural Resources Institute Finland

The climate change scenarios for northern latitudes predict longer growing seasons, increased effective heat sums and precipitation, with higher relative air humidity (RH). Therefore, northern forest ecosystems are exposed to rapid climate change with the interactions of multiple environmental factors. Our aim is to understand the limits of acclimation and adaptation capacity of northern forest trees using *Betula* species as a model system. Impact of climate warming has been studied in a latitudinal translocation experiment with micropropagated silver birch (*Betula pendula*) genotypes at three common garden sites across Finland. The results indicate that the northern genotypes have higher photosynthetic capacity than the southern ones, but the growth potential is limited by strong photoperiodic control. Warming will increase the risk of foliar herbivore damage, with apparent changes in the herbivory community structure. Our new field experiments with four *Betula* species extending from Finland to Italy will provide more data, including genetic analyses. Impact of increasing RH on silver birch and hybrid aspen has been studied in Free Air Humidity Manipulation (FAHM) site in Estonia. High RH disturbed nutrient homeostasis in tree leaves leading to N deficiency and caused a shift in foliar metabolite towards certain carbohydrates, phenolic compounds and antioxidants.

Email: elina.oksanen@uef.fi

Effects of elevated ozone on tree species in China- a review

Feng Zhaozhong, Li Pin, Xu Yansen, Yuan Xiangyang
Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences

In this presentation, we reviewed effects of elevated ozone on tree species in China based on the results in last two decades. The high ozone concentration in summer in most parts of China has induced the typical ozone symptoms in urban forest tree species. By using open-top chambers, elevated ozone affects the growth, gas-exchange rate, foliar microscopy, antioxidant system, BVOC emission. The effects of ozone on biomass accumulation depend on the ozone concentration, tree species sensitivity and exposure duration. Poplar species are very sensitive to ozone. Further studies are conducted on the interactions between O3 and other environmental changes such as increasing CO2 concentrations, increased nitrogen deposition and drought. Future needs for research include the development of O3 flux model for most widely used tree species and assessment of ozone removal by urban foresty in a regional and national scales.

Email: fzz@rcees.ac.cn

Interactive effect of Ethylenediurea, O_3 pollution and insect grazing on willow saplings cultivated in a free-air-O3 system

Evgenios Agathokleous[1],Takayoshi Koike[1], Sayako Kanie[1], Elena Paoletti[2], William Manning[3], Costas Saitanis[4]
1. Silviculture & Forest Ecological Studies, Hokkaido University

2. Institute for Sustainable Plant Protection (IPP), National Council Research (CNR), Via Madonna del Piano 10, Sesto Fiorentino, FL, 50019, Italy
3. Department of Plant, Soil & Insect Sciences, University of Massachusetts, Amherst, MA 01003-9320, USA
4. Lab of Ecology & Environmental Science, Agricultural University of Athens, Iera Odos 75, 11855, Athens, Greece

Willow saplings (Salix sachalinensis) were exposed to ambient O_3 (≈25-35 nmol mol-1, AOZ) or to elevated O_3 (≈60-70 nmol mol-1, EOZ) concentrations in 2014 and 2015. In 2015, plants were treated with foliar sprays of 0 or 400 mg L-1 Ethylenediurea (EDU0 and EDU400 respectively), every 9 days. Growth, photosynthesis and photosynthetic pigments content in O_3-asymptomatic leaves in autumn 2015 and the final biomass production in late September 2015 were measured. EOZ effects on growth were insignificant. However, EOZ suppressed A380 and Amax; EDU400 prevented this EOZ-induced suppression. There was no impact of EOZ on gs380 of EDU0 leaves, albeit gs380 was increased by EDU400 in EOZ. Yet, there was no effect of EOZ on Ci:Ca380, Ci:Ca500, Vcmax and Jmax. Asymptomatic leaves of EDU0×EOZ had lower chlorophyll (TChl) and carotenoids (TCar) contents and TChl/TCar ratio. EDU400 showed a trend towards decreased TChl and TCar contents. EOZ protected plants against insect grazing which was high in AOZ plants such that plants in AOZ and plants of EDU0 in EOZ had similar biomass production. Importantly, plants of EDU400 in EOZ showed higher biomass production than AOZ plants. It seems that EDU protected this species against EOZ through a biochemical mode of action.

Email: evgenios@for.agr.hokudai.ac.jp

Why we cannot ignore soil water limitation when assessing ozone risk to vegetation

Alessandra De Marco[1], Pierre Sicard[2], Silvano Fares[3], Juha-Pekka Tuovinen[4], Alessandro Anav[1], Elena Paoletti[5]
1. ENEA, Casaccia, Rome, Italy
2. ACRI-HE, Sophia Antipolis, France
3. CREA-RPS, Rome, Italy
4. FMI, Helsinki, Finland
5. CNR, Florence, Italy

Phytotoxic Ozone Dose (PODY), defined as the accumulated stomatal ozone flux over a threshold of Y, is considered an optimal metric to evaluate O3 effects on vegetation. PODY is often computed through the DO3SE model, which includes species-specific parameterizations for the environmental response of stomatal conductance. However, most of the previous PODY-based risk assessments did not consider the effect of soil water content (SWC) on stomatal aperture. In this study, we used environmental input data obtained from the WRF-CHIMERE model for 14,546 grid-based forest sites in Southern Europe. SWC was obtained for the upper 10 cm of soil, which resulted in a worst-case scenario. PODY was calculated either with or without water limitation for different Y thresholds. Exclusion of the SWC effect on stomatal fluxes caused a serious overestimation of PODY. The difference increased with increasing Y (78%, 128%, 237% and 565% with Y = 0, 1, 2 and 3 nmol O3 m-2 s-1, respectively). This behaviour was confirmed by applying the same approach to field data measured in a Mediterranean Quercus ilex forest (472%, 697%, 858% and 1037%, respectively). WRF-CHIMERE overestimated SWC at the field site, so differences under real-world conditions were higher than from the model. The differences were lower for temperate species (*Pinus cembra* 50-340%, *P. sylvestris* 57-363%, *Abies alba* 57-371%) than for Mediterranean species (*P.*

pinaster 87-356%, *P. halepensis* 96-429%, *P. pinea* 107-532%, *Q. suber* 104-1602%), although a high difference was recorded also for the temperate species *Fagus sylvatica* with POD3 (524%). We conclude that SWC should be considered in DO3SE simulations and the lowest Y threshold, i.e. POD0, should be used.

Email:alessandra.demarco@enea.it

Increased nitrogen and O_3 changed ectomycorrhizae community structure in three larch species

Takayoshi Koike[1], XiaoNa Wang[2], Laiye Qu[3], Eugenios Agathokleous[1], Dong-Gyu Kam[1] and Yutaka Tamai[1]
1. Graduate School of Agriculture, Hokkaido University, Sapporo 060-8589, Japan
2. Agricultural University of Hebei, Baoding 071000, China
3. Eco-Environmental Research center, Beijing 100085, China

Increases of ground-surface ozone (O_3) concentration and nitrogen (N) deposition to forests are occurred in northern Japan. Japanese larch (JL) was transplanted from central Japan to northern area. However, it suffered from shoot blight disease and grazing by voles. To overcome these weak points of JL, hybrid larch F_1 (F_1) was developed by crossing Dahurian larch (DL) as mother. The susceptibility of JL to O_3 is lessened by increasing N load to soil. Two-year-old seedlings of JL and F_1 were potted in the simulated well-weathered immature volcanic ash soil (VA). For O_3 treatment, seedlings were grown in a free-air O_3 fumigation system (60 nmol mol^{-1} in daytime). And, N was applied in 4 times (totally 50 kg N ha^{-1}year^{-1}) to simulate acid rain. Independent of nitrogen (N) loading, the amount of needle litter was smaller at elevated O_3 than that at ambient. Furthermore, at elevated O_3, we found less sensitivity of photosynthetic activities of JL grown with N loading.

N deposition surely brings phosphorous (P) deficiency because soil was originated from VA. We assessed growth of 3 species of larch seedlings and species richness and infection rate of ectomycorrhizal (ECM) fungi in response to increased N deposition (0 and 100 kg ha^{-1}.yr^{-1}) with/without P (0 and 50 kg ha^{-1}yr^{-1}) for 15 months. Root and shoot biomass were unaffected by N and P treatment for JL, P significantly reduced root biomass for DL, root and shoot biomass of F_1 was distinctly influenced by P and the interaction with N. ECM infection rate was unaffected in DL but the diversity was affected by individual N and P. ECM community structure was distinctly changed for JL not F_1, it potentially resulted in a stable biomass of JL with different treatment. Specific ECM species benefited F_1 of unaffected P content in needles under high N condition. Generally, present finding predicted DL had a lower biomass production with inflexible shift of ECM symbiosis, JL greatly changed ECM community structure with unaffected diversity. The response of F_1 was intermediate between its parents, but obtained a large biomass perhaps due to the tolerance to high N deposition via specific ECM symbiosis.

The ozone foliar injuries reported around Beijing in recent years

Wang Xiaoke
Research Center for Eco-Environmental Sciences, CAS

Ozone (O_3) levels and foliar symptoms were assessed with passive samplers and field investigation at 10 sites in and around Beijing since 2012. In 2012, O_3 levels varied with site locations and ranged from 22.5-48.1 ppb and were highest at three locations. Hourly O_3 concentrations exceeded 40 ppb for 128 hours and 80 ppb for 17 hours from 2 to 9 in August at one site, where it had a real-time O_3 analyzer. Extensive foliar O_3 injury was found on 19 species of native and cultivated trees, shrubs, and herbs at 6 of the 10 study sites and the other 2 sites without passive sampler. After the first report of O_3 foliar injury in and around Beijing. The program of O_3monitoring and foliar O_3 injury assessment in and around Beijing are conducted continually. Our preliminary results showed that there were significant annual variation in O_3 levels and the occurrences in O_3 foliar injuries around Beijing. The continual investigation would be valuable for us to track the trends in ambient O_3 concentration and foliar responses to it and to provide important information for decision making for mitigating O_3 impact.

Email: wangxk@rcees.ac.cn

Forest ecosystem carbon budget and the environmental effect: a case study in a subtropical plantation in China

Wang Huimin[1], Xu Mingjie[1], Wang Yidong[2], Zhang Wenjiang[3], Wen Xuefa[1]

1. Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences

2. Tianjin Key Laboratory of Water Resources and Environment, Tianjin Normal University

3. State Key Laboratory of Hydraulics and Mountain River Engineering, Sichuan University

Forest ecosystem is known as the most important carbon pool of terrestrial ecosystem and affected the global carbon cycling greatly. Afforestation is believed as an effective way in carbon sequestration to mitigate the climate warming. However, the ecosystem carbon pool is greatly affected by both environment fluctuations and human activities in annual scale. In this study, the inter-annual variation of carbon fluxes from both canopy and soil surface were analyzed using a long-term monitoring data in a subtropical plantation in southern China. The results indicated that the low air temperature in early spring, from January to March, was the major factor in controlling the inter-annual variations of net ecosystem carbon uptake, rather than the generally believed summer drought. Because that the temperature in early-spring controlled the plant phenology developing and affected the growing season length in this region. The cold spring greatly shortened the growing season length and reduced the carbon uptake period. The eddy flux observations showed a carbon loss of4.04 g cm^{-2} per day in growing season for this coniferous plantation.

However, as a main component of the ecosystem carbon fluxes, the soil respiration was greatly affected by summer drought. Although this region was characterized by a humid climate with high precipitation (1469 mm•$year^{-1}$), the inter-annual variation of soil respiration was mainly attributed to the changes of annual mean soil water content (P = 0.03), which was dominated by annual precipitation frequency (P<0.01) rather than precipitation amount (P=0.84). Consequently, precipitation pattern indirectly controlled the inter-annual variation of soil respiration by affecting soil water content in the subtropical plantation.

Email: shanghechina@126.com

Impact of climate change on biodiversity in Qinghai-Tibet Plateau in China

Li Diqiang, Duo Hairui
Institute of Forest Ecology, Environment and Protection,Chinese Academy of Forestry

Qinghai-Tibet Plateau is listed as one of 25 important global biodiversity eco-regions by World Wildife Fund because of its rich biodiversity,. We selected 66 types ecosystems and 56 indicator species as priority targets for biodiversity protection in of Qinghai-Tibet Plateau. Then, we identified geographic range shift by simulating the potential range of the indicator ecosystem and species under scenarios of the regional climate model in the 2010s,2050s and 2090s.

The output showed, the eastern part of the plateau will be the most concentrated areas of species richness, and the area will expands toward the northwestern part where elevation is higher under climate change scenarios,. In the central area, species richness will be reduced significantly: the species richness of some big patches will be declines from 5-10 species per 50km2 to 2. between 2050s to 2090s,.In the 2050s and 2090s. The contribution rates for the coverage of nature reserve to the protection of indicator species were 96.11% and 95.72%, respectively.

A adaptation strategies are developed based on the systematical conservation analysis under the scenarios of climate change in the scale of eco-region protection, ecological system, and indicator species, and biodiversity conservation priority area. In order to fill the gap of selected indicator species and priority ecosystem, new nature reserves should set u in 9 areas, and the lower grade nature reserve in the priority areas should to be upgraded as national nature reserve; corridors should establish in the transition zone between Traverse mountain and Sanjingyuan area.

Email: shanghechina@126.com

Session E-03 (40): forest landscape restoration and sustainable development in Northeast Asia

Scientific backgrounds of successful forest landscape restoration in Korea

Hyun Park
National Institute of Forest Science

Even though forest landscape restoration in Korea is a best practice in many developing countries, the role of research for the activity has not been sufficiently described. In this presentation, we would like to show that science and technology has leaded the forest landscape restoration in Korea in success. We extensively reviewed academic journals and relevant documents with regard to the restoration projects. As a result, we could identify significant contributions of five technological areas related to the forest landscape restoration project prior to or concurrently with policies. These five areas were (i) forest survey and inventory, (ii) tree improvement, (iii) seeds and nurseries, (iv) tree planting and tendering, and (v) forest pest control. Based on the review, we could conclude that the forest landscape restoration in Korea was successfully achieved under the fundamental research, which enabled to select suitable species, prepare seedlings, and plant/nurture the trees properly. Meanwhile, we found that official development aid (ODA) contributed significantly to most researches to overcome technical and economic limitations. Therefore, systematic ODA should be provided to develop a scientific and technological base to restore degraded forests in developing countries.

Email: hyunpark@korea.kr

Forest and Landscape Restoration in Northeast Asia

Bomkwon Chun
FAO

According to the Global Partnership on Forest and Landscape Restoration (GPFLR), more than 2 billion hectares of the world's deforested and degraded lands needs to be restored. Forest and Landscape Restoration (FLR) emphasises on balancing between restoring ecosystem goods and services for human well-being. In this context, Forest and Landscape Restoration Mechanism (FLR Mechanism) was officially established at Food and Agriculture Organization of the United Nations (FAO) in 2014. It aims to contribute to meet the goals of Bonn Challenge, Aichi Biodiversity Target and Sustainable Development Goals (SDGs). It is designed to facilitate development and implementation of large-scale FLR programmes and activities in selected countries. The FLR programmes are composed of improving enabling environment, building technical capacity and supporting other concerns related to implementing FLR efforts on the ground. To ensure sustainability of FLR efforts, the FLR Mechanism also supports to enhance networking, to promote partnership with key partners and donors, and to raise public awareness. In Northeast Asia region, the scope of the FLR Mechanism will focus on number of key issues including forest resources management, watershed management and protecting soil erosion, thereby sustainably managing forest and landscape and improving food security.

Email: bomkwonchun11@gmail.com

Forest and landscape restoration in Mongolia

Batkhuu Nyamosor, Gerelbaatar Sukhbaatar, Ser-Oddamba Byambadorj
National University of Mongolia

Mongolia is one of the countries in the world which serious problem with forest depletion, land degradation and desertification. Thus, numerous activities for forest restoration and land rehabilitation had been conducted in Mongolia, but many of the restoration and rehabilitation activities shown poor results due to natural reason, such as harsh climate, and lack of understanding of the ecological characteristics and research capacity. This paper aimed to cover achievements of forest restoration and combating desertification projects conducted recently in Mongolia and to identify the attributes promoting its success in different projects at different part of Mongolia. The success story of northern coniferous forest restoration in Tujiin Nars area and Southern restoration Saxaul forest restoration and reforestation researchers will be introduced. According to researches on restoration and rehabilitation, water (precipitation) is one of the limiting factors which affect planted seedling growth survival in Mongolia and prevention from of livestock grazing and forest fire is also another important factor. For successful rehabilitation of degraded forests or arid southern conditions of Mongolia, standard techniques for species selection and improvement of rehabilitation effects should be integrated in silvicultural treatments and molecular genetics techniques for increased water use efficiency and stress tolerance is needed.

Email: nbatkhuu@gmail.com

National strategy for forest landscape restoration and sustainable development in the DPR of Korea

Kwang Chun Ryu[1], Ho Sang Kang[2]
1. Ministry of Land Environmental Protection, DPR of Korea
2. Seoul National University, Republic of Korea

The major causes of deforestation and land degradation in the DPR of Korea are conversion of forest lands for food and raw materials, over-exploitation of timber and fire woods, forest fires, flood and forest pest and diseases. This has resulted in productivity loss of forest lands, shrinking supply of water resource, sediment of reservoirs, irregular water supply for hydrologic power, decreased biodiversity, increased landslides, and degradation of people's socio-economic measures (e.g. agriculture, NTFPs). In order to address and respond to this, the government has promoted national-scale of forest restoration campaign since 2013, encouraging whole public participation and community-based forest management. In particular, the DPR of Korea has implemented the Forest Development Master Plan (2013-2042) targeting at mixed and multi-purpose forest management with diverse tree species distribution, re/afforestation with agroforestry, enhancement of seed production and nursery capacities, sustainable forest resources utilization, and forest protection through firebreak line, fire monitoring system, forest pest and disease control, sloping land management and soil erosion control. The major challenges in implementing the Plan are limits in technological and material capacities for seed production and collection, seedling production, improved forest management (techniques for natural regeneration and integrated pest management), and weak legal enforcement for protection.

Email: silvi@chol.com

Lamentations and psalms from landscapes: ecological restoration movement and water-soil erosion governance in Changting of China

Zhang Minghui[1], Liu Jinlong[1], Liu Boya[1], Lin Wenqing[2]
1. Renmin University of China
2. The Second Middle School of Changting County in Fujian Province

Forest landscape restoration could be seen as a part of the social movement of ecological restoration (ER), derived from Western environmental protection movement in 1970s, which was a result from continuous efforts of civil society on rethinking development mode of industrialization, social justice, public participation and conservation science and technology. Water and soil erosion Governance (WSEG) in Changting of China has been lasted for nearly 80 years. How could we understand the features and role of the WSEG at an Eastern country in the ER Movement all over the world? This paper illustrated the hundreds-years history of deforestation and forest landscape restoration in Changting at aspects of war, population and livelihood, trade and government efforts, through a method of text analysis on historical literatures and documentation from field researches in years of 2013-2014, in order to show this restoration movement was a process led by elites then to grassroots, focusing on only ecology then expanded to poverty and development, which was the same as the Western history of ER. However, it might be different features that the Chinese traditional culture of "heaven-human harmony" and the local government with certain authority of autonomy.

Email: cathy_minghuizhang@hotmail.com

Session G-03 (62): The role of higher education in promoting sustainable forest management

The Impact of internet of everything on forestry e-learning education

Florin Ioras
Buckinghamshire New Univeristy

Universities play a crucial role in promoting sustainability principles and should contribute to a paradigm shift towards a more sustainable society. They are essential drivers of education for sustainable development (ESD) and constitute fundamental vehicles to explore, test, develop and communicate conditions for transformative change (Disterheft et al. 2013;Leal Filho 2012). But before universities can really promote and drive sustainable development (SD), their sustainability activities must extend a still prevailing narrow perception of sustainability, limited to environmental issues or the simple integration of sustainability topics into existing curricula (Wals 2014; Leal Filho 2009). In order to incorporate SD into the daily life of universities, sustainability has to become mainstream and cannot be implemented as a simple 'add-on'. This mainstreaming or institutionalising is only achieved, when the idea of SD is accepted and integrated into a universities' culture and its day-to-day operations (Lozano 2006a). In short, SD must become an integrative and structural element of all aspects of higher education institutions (HEI) (Tilbury 2011). Without a whole-institution approach that aims at real change and a holistic integration of SD, university are caught in a crossfire of greenwashing, reductionist models and the increasing demand to produce knowledge and students simply for an economy based on unchallenged economic growth.

This paper explores some new challenges facing universities in a global multimediated Internet-based environment, as they seek alternative paradigms and options to remain true to their core business. At a time of rapid technological change, and contested, complex concepts associated with globalisation, knowledge is becoming a primary factor of production in a global economy. Universities face macro challenges of responding to the exponential demand for higher education, decreasing government funding, and the changing nature of knowledge, student expectations and global competition. While advances in the Internet can support constructivist, self-directed interactive learning, its implications for higher education remains complex and problematic. The paper examines potential challenges of new educational approaches on sustainability within the framework of more traditional open learning and e-learning environments. The main challenge is to develop a university that shifts the paradigm from the conventional national university to a sustainable global learning system that maintains quality in teaching, learning, processing and applying knowledge to real-life problems in diverse cultural contexts.

Internet of Everything concept helps to integrate information to facilitate the decision-making process that directs development, acceptance, adoption, and management aspects in agroforestry. Computer-based SD include databases, geographical information systems, models, knowledge-base or expert systems, and „hybrid" decision support systems. The utility of IoE for decision-support in forestry must take into account the limits of our current scientific information, the diversity of aspects (i.e. economic, social, and biophysical) that must be incorporated into the planning and design process, and, most importantly, who the end-user of the tools will be. Incorporating these tools into the design and planning process will enhance the capability of agroforestry to simultaneously achieve environmental protection and agricultural production goals. This paper highlights the relevance of IoE in Forestry education and tries to answer both questions by providing a list of conceptual corner stones and attributes of assessing sustainability at HEI. A number of concluding remarks about sustainability assessment at HEI and related conflicts are proposed by the paper. The paper also looks into future possible usage of IoE and makes recommendations concludes that while the application of information technology to forestry practices nowadays is of tremendous importance it is important to know that there are still more areas where IoE would be applicable in forestry which are yet to be discovered.

Email: florin.ioras@gmail.com United

The main challenges for forestry higher education in Central and Eastern Europe: from curricula to graduate insertion into the job market

Ioan Vasile Abrudan
Transilvania University of Brasov

The paper focuses on the development of the last two decades of forestry higher education in Central and Eastern European (CEE) countries and the main challenges the education system is facing in a changing economic, ownership and legislative context. After the political changes of 1989-1990, forestry higher education expanded rapidly in some CEE countries through the founding of new forestry faculties/departments (e.g. Romania, Poland, the Czech Republic), whilst in other countries the number of faculties/departments remained the same (e.g. Hungary, Slovakia, Bulgaria, Estonia). A common feature in all CEE countries is the significant increase of student numbers compared to the pre-90's period, to a certain degree in line with the ongoing trend of establishing mass higher education in Europe. In addition to the implementation of the Bologna process, forestry curricula were adapted in all countries to the new realities of the forestry sector, including courses/modules related to biodiversity conservation, climate change, social forestry, soft-skills etc. Despite the curricula changes aimed at a better approach to the inter-sectoral issues (environment conservation, rural development, etc.), many forestry schools in Central and Eastern Europe kept their traditional characteristics, compared to Western European countries where the majority of forestry faculties/departments were incorporated into faculties of agriculture, environmental or natural sciences. Maintaining their individual status within the university structure, while pro-actively providing competences for jobs closely related to forestry (administration of protected areas, environment conservation, wildlife management, rural development, etc.) and adapting the curricula to the changing societal needs represent important challenges for the forestry faculties/departments in CEE countries.

Email: abrudan@unitbv.ro

Current trends in forestry higher education in Romania

Alexandru Lucian Curtu
Transilvania University of Brasov

Well-qualified forestry graduates with intellectual skills are needed for a sustainable management of forests. Romania has experienced considerable changes (i.e. transition from a centralized economy to a market oriented one, property restitution process, privatization and also an increased awareness of environmental protection) which have affected the forestry sector over the last 25 years. As a consequence, a greater diversity of objectives had to be addressed in the professional forestry education.A stronger emphasis on biodiversity conservation, communication and social skills, marketing and management of forest enterprises has been given. More broadly educated forestry graduates were able to get jobs in related fields, such as environmental protection (e.g. governmental agencies and administration of natural protected areas). The government policy of promoting access to university education has led to a constant increase in the number of forestry students until recently. However, admission has become less selective and there is a drop in the quality of graduates of some newly established study programs. The challenge remains the attraction of outstanding candidates wanting a career in forestry and the fight against stereotypes associated with forestry profession (e.g. tree fellers, deforestation). Moreover, internationalization of forestry programs should be a priority in a globalized world.

Email: lucian.curtu@unitbv.ro

Need assessment of forestry education in Lao PDR

Mi Sun Park[1], Sojin Youn[2], Bern Donsavanh[2], Yeo-Chang Youn[2], Sianouvong Savathvong[3], Bounxian Phetlumphan[3]
1. Konkuk University
2. Seoul National University
3. Souphanouvong University

It is necessary that higher education in forestry meets the social needs for promoting sustainable forest management. This paper aims to understand the needs of forestry education at the Souphanouvong, Lao PDR. Needs of various stakeholders including the University's faculty members and undergraduate students and Lao governmental agencies were collected through a joint project was carried out by Seoul National University in the Republic of Korea and Souphanouvong University in the Lao PDR during 2015–2016. Needs on subject-specific competencies and generic competencies were measured. Opinions on the necessity in improving forestry curricular of Souphanouvong University were investigated. In practical, the result of this survey will be used for amending forestry curricular at Souphanouvong University.

Email: mpark@konkuk.ac.kr

Session H-3A (29): Multipurpose or single purpose planted forests: which options serve society best?

Multipurpose forestry: role of planted forest in a global perspective

Heinrich Spiecker
Albert-Ludwigs-University Freiburg

The area of planted forests is increasing in many parts of the world. These forests are often planted for a specific purpose. Wood production is one of the most prominent objectives. However, the demand of society for an increasing number other ecosystem services such as protection of soil fertility, water quality, biodiversity, recreation, adaptation to climate change and carbon sequestration is continuously growing. How can planted forest contribute best to provide these services? There are two ways to enhance the delivery of wanted ecosystem services: (1) modification of the management of the planted forest and (2) integrating planted forest in a landscape, which as a whole may provide these services in a satisfactory way. The choice of the management options depend on the specific site condition, the state of the forest and the values of the provided services to the society. Synergies and trade-offs of alternative management options of planted forests for providing multiple ecosystem services are presented.

Email: instww@uni-freiburg.de

Ecosystem services from european planted forests: evolving demand and supply in Atlantic regions

Jean-Michel Carnus[1], Peter Freer-Smith[2], Hervé Jactel[1], Christophe Orazio[3], Margarida Tomé[4]
1. INRA
2. Forest Research
3. EFIATLANTIC
4. ISA

The Atlantic area of Europe is characterised by an oceanic temperate climate favouring diverse forests ecosystems, fast-growing tree species and planted forests which play an important role in the supply of renewable biomass to wood-based industries. In the past, Atlantic planted forests have been mainly managed for the provision of traditional wood products or other NWFPs (Non Wood Forest Products) such as cork or resin. More recently, in the context of emerging bioeconomies and low carbon and climate change related policies, new demands from growing renewable energy markets are addressed to forest owners and managers. Also, with expanding populations in coastal and urban areas, and climatic threats on Atlantic zone (storms, fires, droughts), planted forests are increasingly recognized and used for provision of other ecosystem services (ES) such as coastal protection, soil conservation, regulation of climate and water bodies, and social and cultural services. Case studies for each of the main type of ES will be presented in the context of Atlantic planted forests and analysed using historic approach, recent results from a European network on NWFPs, and review of new demands for ES. Functionnal role of biodiversity in the supply of those ES will be discussed, as well as examples of new ES supply mechanisms and initiatives in the context of forest carbon markets.

Email: carnus@pierroton.inra.fr

New generation plantations: from social learning to social forestry

Luis Neves Silva, David Lindley, Helena Dominguez
WWF

A world with seven billion people requires forestry and farming practices that produce more with less land and water, while empowering communities to achieve their aspirations and improve livelihoods. A premise of the New Generation Plantations (NGP) platform is that skilled, motivated local people can run successful forestry businesses. NGP links forestry companies with communities and governments to unlock funding to scale-up smart forestry investment that shares the benefits and ownership with communities.

Discussions of the social aspects of forestry have, in the past, tended to have a narrow focus. We need to go beyond this as forestry is increasingly expected to address a range of social issues. The NGP is a learning and influencing platform of WWF, companies and governments, in

dialogue to develop sustainable solutions for better plantations. Due to the social-ecological complexities of social forestry, the governance of it is multifaceted and extremely challenging.

The NGP platform, provides a 'safe space', where differing viewpoints from multiple stakeholders can be openly and freely discussed, in an effort to collaboratively develop solutions to complex problems, in an environment conducive to social learning between a variety of stakeholders, developing a foundation for a business's 'social licence to operate'.

Email: lnsilva@wwfint.org

Development of technical framework for multi-functional forest management: its systematic consideration and cases study in China

Lu Yuanchang
Chinese Academy of Forestry

Multi-functional Forest Management (MFFM) is a historical development tendency in China since last decade. Systematic consideration of the MFFM technical framework is crucial and is introduced in the paper. Conceptual structure of MFFM for governing and planning the development progress at national level, and then on design and operation model at management unit level are briefly descript. Technical framework deal with some aspects like life-circle silvicultural model for plantation management, and tree species classification to realize mixtures by enhancing the species interacts. Case studies are also given in regional aspects of demonstration models from tropical to temperate sites. Silvicultural regimes with a series of interfering intensity to meet the needs of different formation of forests are also given as example to show the long-term planning of multi-function forest management development at national scope to operational level.

Email: YLu@caf.ac.cn

Multipurpose management of planted forest: an option for China

Wu Shuirong
Chinese Academy of Forestry

Planted forests in China have undergone a continuous expansion in the past 20 years, which has significantly contributed to an increase in total forest cover and timber supply as well as other ecosystem services like carbon sequestration. However, the predominance of very few tree species in the plantations, uneven spatial distribution, skewed age-class distribution, and low volumes in growing stock, coupled with increasing complexity of multiple purpose forestry management under a changing environment, have generated several major challenges confronting planted forests in China. A strategic transition in the management of Chinese planted forests is needed, with a shifting emphasis from area expansion to stand productivity and quality enhancement, from traditional timber production to multi-purpose management for forest goods and services, and from monoculture plantations to biodiversity rich mixed forests. Based on an overall view of the challenges of planted forests and the alternative management options, this paper presents case studies and suggestions for the multipurpose management of planted forest for China.

Email: shuirongwu@126.com

Session H-3B (67A), H-4B (67B): Nanotechology for biobased materials

Fabrication and characterization of supercritical CO2 drying of spherical nano-cellulose aerogel

Wang Xiaoyu[1], Zhang Yang[1], Jiang Hua[2], Song Yuxuan[1], Zhou Zhaobin[1], Zhao Hua[1]
1. College of Materials Science and Engineering, Nanjing Forestry University
2. College of Chemical Engineering, Nanjing Forestry University

The purpose of this paper is to prepare highly porous nano-cellulose aerogels through a spontaneous physical gelation route using calcium chloride solution in combination with solvent displacement and supercritical CO2 drying technology. The induction of calcium chloride solution maintained the shape of nano-cellulose gel while dropping and facilitated physical gelation due to the cation and anion in calcium chloride solution destroyed the stability of cellulose making the nano particles more likely to be close to each other to form gel. The supercritical CO2 drying provided preservation of the original network and structure. The prepared white spherical nano-cellulose aerogels were characterized with respect to shrinkage, specific surface area as well as thermal degradation and micro-structure via SEM. The nano-cellulose aerogel exhibited a nano-porous network structure composed of mesopores mainly as well as a higher specific surface area of up to 353 m2/g with an average pore size of 8.86nm and suffered from a weak shrinkage of 4.03%. At the same time, it showed a similar thermal degradation behavior of MCC, NCC.

Email: 476675132@qq.com

Manufacture of electrospun all-aqueous poly(vinyl alcohol)/cellulose nanocrystal composite nanofibrous mats with enhanced properties through controlling fibers arrangement and microstructure

Huan Siqi, Liu Guoxiang, Han Guangping
Northeast Forestry University

Uniform fibers composed of two concentrations of poly(vinyl alcohol) (PVA) separately reinforced with up to 20 wt% cellulose nanocrystals (CNCs) were successfully fabricated with fiber diameters in the nanoscale range via an electrospinning process. The CNCs were well dispersed in both 5 wt% PVA (5PVA) and 7 wt% (7PVA) aqueous solution prior to nanofiber manufacture. Composite nanofibers with controllable ultra-thin diameters of around 200 nm were generated reproducibly at all CNC contents investigated. PVA/CNC nanofibers became more uniform and finer with increased CNC content due to the synergetic effect of electric conductivity, interfacial tension, and viscosity of electrospinning solutions. Morphological investigation of obtained nanofibrous mats demonstrated that the transition from incompact stacking to compact alignment in structure was achieved by changing the CNC loading from 0 to 20 wt% and the concentration of electrospinning solutions from 5 to 7 wt%. Interestingly, with the same CNC loading, nanofibrous mats produced from 7PVA reinforced with CNC nanoparticles had higher degree of crystallinity than nanocomposite with 5PVA as the matrix due to the more orderly stack of 7PVA nanofibers as well as the stronger interactions between PVA molecular chains and CNC nanoparticles. Moreover,

the mechanical properties, especially the maximum tensile stress, of nanofibrous mats fabricated from 7 wt% PVA were better than those of the 5 wt% PVA counterparts, demonstrating that the microstructure of electrospun nanofibers resulted from the molecular interactions of CNCs and PVA chains could be beneficial to the mechanical properties of electrospun composite nanofibrous mats. Finally, this study showed the possibility to develop an all-aqueous electrospinning PVA system enhanced by CNCs for its potential applications in high-performance field.

Email: siqi.huan@nefu.edu.cn

Characterization of aspect ratio of cellulose nanocrystal by rheology method

Wu Qiang[1], Li Xiuwen[1], Wang Siqun[2]
1. Zhejiang A&F University
2. University of Tennessee

The objective of this study is to use rheology as a simple morphology characterization method for cellulose nano-crystal (CNC). In order to give accurate CNC morphology, the influence of NaCl concentrations on the stability, effective diameter and rheological behavior were investigated by dynamic light scattering and Ubbelohde viscometer. With NaCl concentration increasing, the stability of CNC suspensions decreased, while the effective diameter and intrinsic viscosity first decreased and then increased. This phenomenon was attributed to screening effect of double electric layers on CNC at lower NaCl content, and promoting CNC aggregation at higher NaCl content. CNC aspect ratio calculated by Simha model was very close to that of TEM statistical results, which indicated that the rheological method is a viable method for CNC aspect ratio characterization, however, the electrostatic repulsion effect cannot be ignored for aspect ratio characterization by rheology method, and in addition of NaCl would obtain CNC aspect ratio more accurate.

Email: wuqiang@zafu.edu.cn

Coherent interface assembled highly porous Ag2O@nanofibrillated cellulose aerogels for Iodine capture

Lu Yun, Yin Yafang
Research Institute of Wood Industry, Chinese Academy of Forestry

Nanofibrillated cellulose (NFC) with high aspect ratio has received increasing attention due to its abundance and fascinating physical features to application as reinforcing scaffold in composites. In this work, highly porous NFC aerogels were prepared based on bamboo NFC with 20-80 nm diameters. Then non-agglomerated 2-20 nm silver oxide (Ag2O) nanoparticles (NPs) were grown firmly onto the NFC scaffold with a high loading content of 500 wt% to fabricate organic-inorganic composite aerogels (Ag2O@NFC). For the first time, the coherent interface and interaction mechanism between the cellulose Iβ nanofiber and Ag2O NPs are explored by HRTEM and 3D electron tomography. Specifically, strong hydrogen bond between Ag2O and NFC makes them grow together firmly along coherent interface, where good lattice matching between specific crystal planes of Ag2O and NFC results in very small interfacial straining. The resulting Ag2O@NFC aerogels fully take the advantage of 3D organic framework and the inorganic NPs, such as large surface area, interconnected porous structures,and supreme mechanical

properties.They open up a wide horizon for functional practical usages, like flexible super-efficient adsorbent to capture I- ions from contaminated water and trap I2 vapor for safe disposal, as presented in this work. The viable binding mode between many types of inorganic NPs and NFC established here highlights new ways to investigate cellulose-based functional nanocomposites.

Email: y.lu@criwi.org.cn

Novel organic-inorganic hybrid nanocomposites based on sticky rice lime mortar and cellulose nanocrystals

Lu Qilin
Fujian Agriculture and Forestry University

Sticky rice lime mortar (SRLM), an ancient Chinese super-strong mortar made from sticky rice, is one of the important inventions in ancient China. Inspired by this, cellulose nanocrystals (CNCs) and sticky rice lime mortar were used for the preparation of organic-inorganic hybrid nanocomposites and sticky rice lime mortar nanocomposites. The investigation on the characteristics of the nanocomposites showed that CNCs played an important role in the improvement of mechanical strength and physical properties, with the compressive strength and surface hardness of the nanocomposites increasing by 156% and 147%, respectively. Meanwhile, with the aid of CNCs, the carbonation degree of the organic-inorganic hybrid nanocomposites increased. The structure of the nanocomposites was more compact, and the size of the calcium carbonate crystals was smaller. Moreover, CNCs as the natural biological polysaccharide in the lime mortar nanocomposites has a regulatory role in the biomineralization process of carbonate, controlling the size and shape of the calcium carbonate crystals and leading to the production of a compact microstructure. This is the fundamental cause for the excellent properties of this kind of organic-inorganic hybrid nanocomposites.

Email: 492619491@qq.com

Fabrication and characterization of electrospun cellulose nanocrystals /poly (methyl methacrylate) nanocomposite fibers

Xiaohui Ni, Siqi Huan, Guangping Han, Wanli Cheng
College of Material Science and Engineering

An electrospinning process was successfully utilized for fabricating cellulose nanocrystals / poly(methyl methacrylate) (CNC/PMMA) nanocomposite fibers. The influence of CNCs content on the Morphology, thermal property and mechanical performance of the obtained nanocomposite fibers were investigated. The results showed that fibers surface of CNC/PMMA remained smooth, the fiber diameter gradually decreased and the diameter distributions became narrow with increasing the CNCs content. CNCs could increase the thermal property of the nanocomposite fibers. The glass transition temperature and the maximum thermal decomposition temperature of CNC/PMMA fibers were increased to 120.3 oC and 370 oC with inclusion of 20 wt% CNCs. Tensile test indicated that the incorporation of CNCs could improve tensile strength of electrospun mats and the maximum tensile stress was 0.3 MPa at 20 wt% CNCs loading (almost 2-fold compared with electrospun PMMA fibers).

Email: 502002461@qq.com

Thermoset composites from two-component waterborne polyurethane with nanofibrillated cellulose

Wu Guomin[1], Kong Zhenwu[1], Wang Siqun[2,1]
1. Chinese Academy of Forestry
2. University of Tennessee

Thermoset nancomposites were prepared from a two-component waterborne polyurethane (2K-WPU) incorporated with different contents of high aspect ratio nanofibrillated cellulose (NFC). Effects of NFC addition on viscosity and particle size distribution of the 2K-WPU dispersion were investigated by rotational rheometer and laser particle size analyzer, respectively. Viscosities of the 2K-WPU/NFC dispersions increased sharply and particle sizes of the 2K-WPU/NFC dispersions increased slightly with the increase of NFC content. Fractography images from scanning electron microscopy (SEM) showed rough structures appearing in the nancomposites structure, which corresponded to the microphase separation between NFC nano-filler and the 2K-WPU matrix. This microphase separation phenomenon led glass transition temperature (Tg) and break elongation of the 2K-WPU/NFC nanocomposites to decrease with the increase of NFC content. Tensile tests and dynamic mechanical analysis (DMA) indicated all the 2K-WPU/NFC nanocomposites showed simultaneous enhancements in modulus and tensile strength, compared with those for the neat 2K-WPU (0 wt %). The enhancements can be attributed to strong interactions resulting from the formation of hydrogen bonds and chemical grafting between NFC nano-filler and the 2K-WPU matrix.

Email: wooguomin@163.com

Degradation characterization of cellulose nanofibrils with different chemical composition by Quartz Crystal Microbalance

Akio Kumagai[1], Seung-Hwan Lee[2], Takashi Endo[1]
1. Research Insititute for Sustainable Chemistry, National Institute of Advanced Industrial Science and Technology
2. College of Forest and Environmental Science, Kangwon National Institute

Cellulose nanofibrils (CNF) with different chemical composition were prepared by the combined method of steam or hot-compressed water treatment and disk-milling. Chemical composition was also adjusted by the sodium chlorite-acetic acid method. QCM-D is known as an appropriate technique for in situ and real-time studies of phenomena occurring at the solid–liquid interface. The CNF thin film was prepared on a gold sensor for Quartz crystal microbalance with dissipation (QCM-D) analysis. The effect of different chemical composition on enzymatic hydrolysis was investigated. The enzyme adsorption amount in CNFs was increased and was greater in CNFs with low lignin content. Initial enzymatic degradation was substantially slowed in CNFs with high lignin content, particularly after HCW treatment at temperatures higher than 180℃. It suggests that the steric hindrance of the deposited lignin is the primary mechanism by which the initial enzymatic hydrolysis is delayed. The impact of changes in hemicellulose by steam treatment on enzymatic hydrolysis was also monitored by QCM-D using Acremonium cellulase as a source of multicomponent enzymes including hemicellulases. CNFs without stream treatment showed distinctive initial changes in frequency and energy dissipation, which differed from those of pure cellulose film, whereas these changes shifted toward typical changes of enzymatic hydrolysis of pure cellulosic films with increasing stream treatment temperature. It was suggested that hemicellulose located around cellulose microfibrils is rapidly decomposed, thus exposing the

cellulose surface shortly after initial enzymatic hydrolysis, and then the main enzymatic hydrolysis of cellulose occurs.

Email: a-kumagai@aist.go.kr

Next-generation lignocellulose-derived thermoplastic composites

Wang Jifu, Yu Juan, Wang Chunpeng, Chu Fuxiang
Institute of Chemical Industry of Forest Products, Chinese Academy of Forestry

With the depletion of fossil oil, a major feedstock for polymers, a lot of attention has gradually shifted towards the development of sustainable materials derived from renewable resources in recent years. lignocellulose, being the largest naturally abundant biomass, was viewed as one of the potential candidates to replace fossil oil to produce new energy and materials. In our work, a novel strategy for the synthesis of lignin and cellulose nanocrystals (CNCs) derived thermoplastic elastomers was presented. By the using of the "grafted from" atom transfer radical polymerization (ATRP), poly(methyl methacrylate-co-butyl acrylate) was grafted into lignin and CNCs, respectively. These copolymers were regarded as sustainable thermoplastic elastomers. These results indicated that lignin, as well as CNCs, can significantly increase the mechanic properties of these composites. Specially, the unique property of lignin such as UV-absorbent ability was also afforded to these composites.

Email: wjf118@126.com

Synthesis and characterization of antibacterial paper from abaca hybrid 7 with nanostructured zinc oxide particles prepared through microwave irradiation technique

Ronniel Manalo[1], Saberina I. Saberon[2], Monet Concepcion M. Detras[2], Maria Victoria P. Migo[2], Marvin U. Herrera[3]
1. Department of Forest Products and Paper Science, College of Forestry and Natural Resources, University of the Philippines
2. Department of Chemical Engineering, College Engineering and Agro-Industrial Technology, University of the Philippines
3. Institute of Mathematical Science and Physics , College of Arts and Sciences University of the Philippines

Nanostructured zinc oxide (ZnO) particles were grown on paper substrate made from Abaca hybrid 7 pulp. Microwave radiation technique was used at power levels of 180 and 540W and exposure times of 5, 10, 20 and 25 minutes. Chemical transformations were observed using Fourier Transform Infrared (FTIR) Spectroscopy. The effects of the power levels and exposure times on the morphology of the nanostructures were determined using optical and scanning electron microscopy. Parallel Streak Method was used to evaluate the antibacterial activity of the samples against Escherichia coli. FTIR spectra proved the embedment of ZnO on the paper substrate. Power levels and exposure times affected the distribution, particle size and structure of the ZnO nanoparticles. Higher power level and longer exposure resulted to the formation of more ZnO with larger particles. Grain-like and flower-like ZnO nanostructures were formed at lower and higher levels, respectively. Samples prepared at 180W for 25 minutes, 540W for 10 minutes, 540W for 20 minutes showed complete inhibition of E. coli under dark condition. The antibacterial activity of the samples was correlated to the morphology of the ZnO nanostructures. Based on

this study, antibacterial paper with ZnO can be produced more effectively with microwave irradiation at 540W for 10 minutes.

Email: rdmanalo@up.edu.ph

Layer-by-layer structured carbon nanotube-polyaniline coated cellulose/cellulose nanocrystal aerogel electrode for electrochemical applications

Lyu Shaoyi[1], Chang Huanjun[1], Fu Feng[1], Guo Limin[1], Wang Siqun[1,2], Chen Zhilin[1]
1. Research Institute of Wood Industry, Chinese Academy of Forestry
2. Center for Renewable Carbon, University of Tennessee

An interesting electrode was produced in an electrostatic layer-by-layer (LBL) assembly process of negatively charged carboxylic multi-walled carbon nanotube (CMWCNT) and positively charged polyaniline nanorods (PN) on wood pulp cellulose/cellulose nanocrystal (WPC/CNC) aerogel substrates. We employed the above electrode to fabricate a solid-state supercapacitor using PVA/H3PO4 gel that functioned simultaneously as electrolyte and separator. WPC/CNC acted as negatively charged carrier material with unique porous structure and hydrophilic characteristics. These particular properties gave this electrode an excellent areal capacitance of 352 mF cm-2 at a low sweep rate of 1 mV s-1 and high cyclic stability with 97.1% retention of the initial capacitance after 5000 cycles. The fabricated flexible WTSS-RGO supercapacitor cell also had a high areal power density of 0.44 mW cm-2 and exhibited high mechanical flexibility. Our study introduces a new and eco-friendly material design for electrodes in future flexible energy storage devices that closely resemble natural materials.

Email: lvsy@caf.ac.cn

Study on the cellulolse nanofibrils (CNFs)-based aerogel with high strength and flame retardant properties

Guo Limin
Chinese Academy of Forestry

The previous studies indicate that the natural cellulolse nanofibrils (CNFs) are interesting building blocks to prepare aerogels. However, CNFs are highly flammable and the mechanical strength of the pure CNFs aerogels is very weak in high humidity environment, which is unfavorable for safety concern and not practical when CNFs aerogels were used in building materials or domestic applications. In this work, we used graphiteoxide (GO) and 1,2,3,4-butanetetracarboxylic acid (BTCA) as the co-additive, then prepared a kind of crosslinked CNF aerogels with high strength an flame retardantand properties by simply using freeze drying method. The microstructure of the CNFs aerogels was studied by scannin electromicroscopy (SEM),GO was found to be well-dispersed throughout the CNFs. The flame retardancy of the aerogels were investigated by limiting oxygen index (LOI), cone calorimeter (CONE) and TG analysis. The results showed that the addition of GO obviously reduced the total heat release in this system, and the aerogel demonstrated very fast self-extinguishing times in vertical open flame tests. The results of the uniaxial compression tests showed that this cross-linked CNFs-based containing GO aerogel with excellent compression and resilience performance.

Email: guoliminv@163.com

Click reaction and self-assembly for hollow nanospheres derived from renewable lignin

Han Yanming [1], Xiong Fuquan[1], Wang Siqun[1,2], Li Gaiyun[1], Chu Fuxiang[1]
1. Research Institute of Wood Industry, Chinese Academy of Forestry
2. Center for Renewable Carbon, University of Tennessee

Controllable fabrications of nanomaterials from renewable natural resources have recently become an increasingly important research branch in materials area. Lignin is one of the principal constituents of wood and is the second most abundant natural polymer. In this paper, azide groups, polyethylene glycol chains and other polymer chains were grafted onto lignin via click chemistry. Self-assembly for fabricating lignin hollow nanospheres with size tunable single holes through employing pre-dripping lignin concentration was introduced. The structure and formation mechanism of the hollow spheres was investigated. The effect of modified molecular chains on the click reactions and the self-assembly of lignin nano structure was studied, as well as the effect of pre-dropping lignin concentration on the nano structures. Results showed that increasing the pre-dropping lignin concentration brought about an increase of the diameter of the hollow nanospheres and the thickness of shell wall, while the diameter of the single hole, the surface area and the pore volume of the hollow nanospheres decreased. This research could provide new method for the bio nano-materials derived from lignin and the value-added application of renewable lignin resources.

Email: hanym@caf.ac.cn

Cellulose nanofiber fabrication by two-steps with enzymatic pretreatment and mechanical grinding

Chen Yuan
Research Instititude of Wood Industry, Chinese Academy Forestry

Cellulose nanofiber (CNF) has potential application on several sectors, including the development of innovative materials, as well as enhancement of conventional materials properties. Therefore, this paper focused on a potentially novel, low-energy consumption approach for CNF fabrication at large scale by enzymatic pretreatment and mechanical grinding from wood pulp. The two-steps production route was (1) enzymatic pretreatment using cellulase from trichoderma viride and (2) mechanical grinding for three times. The properties of nanofibers were characterized by using Scanning Electron Microscopy(SEM), Transmission Electron Microscope(TEM), Fourier Transform Infrared Spectrometer, (FTIR) and X-ray Diffractometer(XRD). The research studied the effects of enzyme dosage and hydrolysis time, which investigated the enzyme mechanism on wood pulp and the influence on CNF diameter and length. The results showed that the cellulase effected on the pulp by layer-up-layer, including crystalline and amorphous regions. In addition, the mechanical grinding were further reducing crystalline region, resulted in the sharp decrease of crystallinity. And an enzyme pretreatment could effectively reduce the diameter and length of CNF. Moreover, the two-steps production route could control preparation time and energy consumption effectively. Further integration of enzyme pretreatments with mechanical grinding provides a promising efficient process with low environmental impact for production of CNF.

Email: chenyuan@criwi.org.cn

Nano pores structure in wooden based activated carbon fibers and its application

Lin Jian, Rattana Choowang, Guang-jie Zhao
Beijing Forestry University

Steam activation were performed to prepare activated carbon fibers (ACFs) from liquefied wood. The evolution and formation mechanism of the nano pores structure in wooden based ACFs under different activation processes was investigated comprehensively. As the increase of activation temperature or activation time, the BET specific surface area and total pore volume were increased. When activated at 650-800℃, the micropores (mi) kept constant. When activated at 850-950℃, the micro/mesopore (2-50nm) size was enlarged. With the burn off being more than 75%, the Smi decreased sharply accompanied by the collapse of micropores smaller than 0.8nm. When the burn-off was more than 90%, the maximum mesopores ratio was about 49.5% and mesopores at 2-5.8nm were formed. The specific capacitance of ACFs reached 280F/g in 1M H_2SO_4 electrolyte. The specific capacitance retention ratio after 2000 charging-discharging cycles at 10A/g reached up to 99.3%. The good supercapacitor performance of liquefied wood based carbon fibers was due to large Smi (2300m2/g) and mesopores at 3-4nm connected reciprocally. Besides, ACFs showed higher adsorption capacity of iodine and methylene blue.

Email: linjian0702@bjfu.edu.cn

Session A-04 (32): Development of adaptation strategies for climate change using GM trees programs

Xylem-specific expression of PdGA20ox1, a gibberellin 20-oxidase 1 from *Pinus densiflora*, dramatically increases stem growth and xylem differntiation without showing undesirable phenotypes

Mina Choi, Muho Han, Eung-Jun Park
National Institute of Forest Science

The concentration of growth-active gibberellins (GAs) in growing tree stems is controlled by transcriptional regulation of genes, and modifying the expression of these genes can alter tree growth rate. In this study, we conducted the functional characterization of a PdGA20ox1 from *Pinus densiflora* using transgenic approaches. Overexpression of PdGA20ox1 under the control of the 35S promoter significantly enhanced wood formation with fiber development in a transgenic hybrid poplar (*Populus alba*×*P. glandulosa*). Microarray analyses revealed that ‘Cell organization or biogenesis’- and ‘cell wall’-related genes were overrepresented, including many of genes that are involved in cell wall modification. In contrast, genes involved in defense signaling were appreciably downregulated in the 35S::PdGA20ox1 stem tissues, suggesting a growth versus defense trade-off. To overcome this problematic trade-off, we employed developing xylem (DX)-preferential production of GA in transgenic poplar trees. Both transgenic poplar trees (35S::PdGA20ox1 and DX15::PdGA20ox1) showed dramatic increases in biomass, up to 300%, with accelerated stem growth and xylem differentiation. Cell wall monosaccharide composition analysis revealed that glucose and xylose contents were significantly increased. However, DX15::PdGA20ox1 poplar resulted in a reduction of undesirable phenotypes of 35S::PdGA20ox1 poplar, including poor root growth and leaf development. Taken all together, we conclude that the controlled production of GAs through a tissue-specific promoter might be an efficient biotechnological tool for developing trees with enhanced plant biomass and bioenergy production, simultaneously.

Email: mnchoi1022@korea.kr

Downregulation of stress associated protein 1 (PagSAP1) increased tolerance to salt stress in a hybrid poplar (*Populus alba* × *P. glandulosa*)

Seo kyung Yoon[1,2], Eun Kyung Bae[1], Hyoshin Lee[1], Young Im Choi[1], Hyunmo Choi[1], Kyu Suk Kang[2], Eung Jun Park[1]

1. National Institute of Forest Science, 39 Onjeong-ro, Suwon 441-847

2. Seoul National University, 1 Gwanak-ro, Seoul 151-742

Plants have evolutionally developed defense mechanism to cope with climate change catastrophes such as salinity, drought, and extreme temperatures. Such adaptive strategies include fine-tuning of Stress Associated Proteins (SAPs). In this study, we investigated molecular and physiological characteristics of a novel PagSAP1 from hybrid poplar (Populus alba × P. glandulosa) in response to salt stress. PagSAP1 contained an A20 and AN1 zinc-finger domain at N- and C-terminal, respectively. Salt stress significantly downregulated the expression levels of PagSAP1 in both suspension cells and plants at 7-leaf stage. Compared to the control plants, the RNAi transgenic poplar plants showed strong tolerance to salt stress, while the overexpression of PagSAP1 increased salt sensitivity. The analysis of Na+ and K+ contents in roots and leaves followed by salt treatment (NaCl 150 mM) revealed that the RNAi plants accumulated less Na+ and more K+ than the PagSAP1 OX did. Furthermore, the RNAi lines increased the expression of genes involved in cation transport across plasma membrane such as H+-ATPase, AAA-type ATPase, the salt overly sensitive 1 (SOS1) and Arabidopsis K+ channel (AKT2). Moreover, yeast two-hybrid analysis showed that PagSAP1 directly interact with polyubiquitin and voltage dependent anion channel2 (VDAC2), respectively, suggesting that the downregulation of PagSAP1 enhanced salt tolerance through regulation of VDAC2.1 protein by ubiquitination. All these results showed that PagSAP1 might be a potentially useful candidate gene for engineering tolerance improvement to salt stress in trees.

Email: yoonsk0712@naver.com

Helix-loop-helix transcription factor PagBEE3L enhanced biomass production by proliferating xylem cells in poplar

Hyunmo Choi[1], Seol Ah Noh[1], Jin-Seong Cho[2], Eun-Kyung Bae[1], Hyoshin Lee[1], Eung-Jun Park[1], Young-Im Choi[1]

1. National Institute of Forest Science

2. Kyung Hee University

Reduction in greenhouse gas emissions has been an important issue to address the climate change and there is increasing interest in the use of forest biomass for bioenergy to offset energy from fossil fuels. Plant hormone brassinosteroids (BRs) play important roles in many aspects of plant growth and development, including regulation of vascular cambium activities and cell elongation. Here, we identified brassinosteroid enhanced expression 3-like gene, PagBEE3L, encoding a putative basic helix-loop-helix (bHLH)-type transcription factor from hybrid poplar (Populus alba× P. glandulosa).. Expression of PagBEE3 was induced by brassinolide. Transcripts

of PagBEE3 were mainly detected in stems, with the internode having a low level of transcription and the node having a relatively higher level. The function of the PagBEE3 was investigated through phenotypic analyses of PagBEE3-overexpressing (ox) transgenic lines. This work particularly focused on a potential role of PagBEE3 in stem growth and development of polar. The PagBEE3-ox poplar showed thicker and longer stems than wild-type plants. The xylem cells from the stems of PagBEE3-ox plants revealed remarkably enhanced proliferation, resulting in an earlier thickening growth than wild-type plants. These results showed that xylem development of poplar is accelerated in PagBEE3, suggesting that PagBEE3 played an important role in stem growth by increasing the proliferation of xylem cells.

Email: choihyunmo@gmail.com

Pine trees and gravity

Elspeth MacRae, Lorelle Phillips, Armin Wagner, Lloyd Donaldson, Heather Flint, Glenn Thorlby
Scion, 49 Sala St, Rotorua, New Zealand.

Trees defy gravity and grow upwards in most situations, and this forms the basis for growing trees for timber and fibre applications. When a tree bends, wood cells with specialised walls are produced by the cambium that force the tree to return to upward growth. In conifers, these cells that develop at the base of the bend –known as compression wood, are enriched in the cell wall polymer â1-4 galactan. An Aspergillus endo-â1-4 galactanase was engineered into Pinus radiata and targeted to the Golgi apparatus. This caused a 70-75% reduction in galactan content in the compression wood and effectively eliminated the tree’s ability to respond to gravitropism. Trees otherwise grew normally.

Session D-04 (73): Long-term flux monitoring using forest tower measurement - Interaction with forest and environmental condition change

Influence of disturbance on GPP in a deciduous broadleaf forest: extrapolating photosynthetic parameters from long-term CO2 flux monitoring data

Yasuko Mizoguchi, Katsumi Yamanoi
Forestry and Forest Products Research Institute

Flux and meteorology observation have been conducted for over 15 years in the deciduous broadleaf forest in the northern part of Japan. Typhoon in 2004 and an insect attack in 2014 decreased the amount of leaves of upper story trees. The amount of leaves is related to gross primary production (GPP). We therefore extrapolated photosynthetic parameters using the relationship between leaf area index (LAI) and observation data before and after disturbances. Then we estimated GPP using these parameters. This evaluating method showed good performance without a large number of parameters. Next, we estimated GPP when disturbances didn’t happen. The results showed that a part of the decrease in photosynthesis by the typhoon damage was compensated by understory vegetation and the loss of GPP by the insect damage in summer was large.

Email: pop128@ffpri.affrc.go.jp

Geographical variation of forest carbon budget under the changing climate in Japan

Katsumi Yamanoi, Yasuko Mizoguchi
Forestry and Forest Products Research Institute

Consequence of climate change is predicted a geographical variation in Japan. Carbon budget in a forest ecosystem will be subject to influence of the climate change. The purpose of this study is to make a prediction of the future carbon absorption in forest ecosystem using the forest tower measurement data, the ecological process model (Biome-BGC) and the forecast scenario of climate. We used three sites of FFPRI FluxNet to calculate the future carbon budget by Biome-BGC. Annual mean temperature of Sapporo site (SAP), Fujiyoshida site (FJY) and Kahoku site (KHW) were 7.3, 9.5 and 15.3 ℃, respectively. Carbon budgets under the warner and the present climate were compared on three sites. Increased temperature gained both gross primary production (GPP) and ecosystem respiration (Re) on each site. But Re was more sensitive to changes in temperature. Under the future warmer condition, net primary production (NEP) was increased on SAP and decreased on FJY and KHW. NEP was varied with the initial temperature among sites.

Email: yamanoi@affrc.go.jp

Longterm estimation of carbon balance for a warm temperate mixed forest in Japan

Yuji Kominami[1], Takafumi Miyama[1], Mioko Ataka[1], Kennichi Yoshimura[2], Masako Dannnoura[2], Mayuko Jomura[3]
1. Forestry and forest research institute
2. Faculty of Agriculture, Kyoto University, Japan
3. College of bioresource science, Nihon University, Japan

About 40% of forest area (10 million ha) in Japan is covered with secondary broad-leaved trees. These forests had been over harvested until first half of 20 century and after then almost abandoned. NEE (NEP) of such unmanaged forest has still much uncertainty because is highly influenced by past stand conditions (e.g. CWD production). The study was conducted in the Yamashiro Experimental Forest (YMS: temperate secondary broad-leaved forest in central Japan, 34°47'N, 135°50'E). *Quercus serrata* is a dominant species in the site. Annual mean air temperature was 15.5 °C and annual precipitation was 1449 mm in 2002. Tower CO2 flux have been measured from 2000(Kominami et. al. 2008). Since the 6th century, the forests around the study site have been harvested heavily then abandoned In the 1900s, an extensive reforestation effort using P. densiflora was carried out. From the last half of the 1970s to the first half of the 1980s, most of these trees were killed by the pine wilt disease. Broadleaved species such as *Q. serrata* and evergreen species as I. pedunculosa that had invaded the site during the 1960s gradually became the dominant canopy species. Consequently, much CWD produced by *P. densiflora* existed in the site(Jomura 2006). In this study, we report the cross validation of tower flux, chamber and modeled (Roth-C and Biome) NEP of YMS.

Email:kominy@ffpri.affrc.go.jp

Session E-04 (38): Forest and landscape restoration in Central Asia

Prctice of forest restoration in Kazakhstan

YuliyaBorissova[1],Sabit Baizakov[1],Bolat Mukanov[2]
1. Kazakh National Agrarian University
2. Kazakh Scientific Research Institute of Forestry and Agroforestmelioration

4.6% of the Kazakhstan Republic territory is covered by forests. There are six forest growing zones: four are located on flatlands (forest-steppe, steppe, desert and intrazonal floodplain), and two - in mountains (Altai, Saur and Tien Shan forests). Degradation processes occur in almost all forests of Kazakhstan.

Forest restoration based on seeding and planting seedlings have received system development since 1946. Reforestation conducted on 2.6 million hectares, about half of which were survived. Forest melioration conducted on 55 thousand hectares on the dried bottom of the Aral Sea. Forest plantations were planted in forest deficit regions of Kazakhstan. Around Astana city, a green forest belt of 65 thousand hectares was created.

However, original technology for growing thickened massive forest cultures with one main tree species seedlings is still operated without significant changes. Although long practice has shown that such cultures are not sustainable to climatic conditions of Kazakhstan and are fire hazard, cost-intensive and ineffective. Therefore, conducted research in pine forests near the Irtysh River we have developed two new techniques of forest restoration (block and fallopian-transit); protected by innovative patents of Kazakhstan.

Forest restoration on these methods in 8-12 times reduces costs of seedlings, labor and thinning volumes, promotes transformation of silvicultural production on new scientific and technological level.

Email: yulkolser@mail.ru

Forest landscape restoration in Central Asia

John Stanturf
US Forest Service

Forests of central Asia occur primarily at upper elevations where forest types follow elevational and climatic gradients. Mountain forests are important biodiversity hot spots as well as the water towers for central Asian rivers. Natural and anthropogenic disturbances have created the need for landscape restoration, which runs the gamut from reclamation of degraded land (salinized or waterlogged soil, mined land) to mixed plantings for watershed protection, wood supply, and non-timber forest products. Major threats are from over-harvesting for use as fuel wood and housing construction, overgrazing, unsustainable exploitation of non-timber forest products, wind and water soil erosion on sloping lands, and conversion to other land uses such as urban development, mining, and agriculture. Obstacles to fully implementing needed restoration are inadequate legal framework for sustainable forest and land management, needed reform of land tenure, outdated approaches to sustainable forest and land management that rely too heavily on protection and passive management, limited capacity of local institutions, and of course lack of adequate financial resources for forest management. In addition to restoring and maintaining closed forests, agroforestation has great potential to increase trees in mosaic landscapes. Windbreaks, fruit tree-based agroforestry, and alley cropping have been advanced as potential improvements to farmers.

Email: jstanturf@fs.fed.us

Forest landscape restoration by artificial plantation and forest tending in Korea

Joo HanSUNG,Young GeunLEE
National Institute of Forest Science

Forest is covered over 6,400,000ha in ROK, accounting for 63.4% of ROK's territory. In late 2014, conifer forest 40.5%comprises the largest area in ROK forest land; and the rest consists of 27%of broadleaved forest, 29.4% of mixed forest, and 3.7% of unstocked land. The growing stock per ha jumped about twelve times, from 10.5m3 in 1952 to 126m3 in 2010. The fundamental causes of forest degradation that ROK had been suffered since 1945 can be summarized as 1) the Korean War 2) population growth 3) poverty and 4) lack of administrative power. And also, the direct causes of forest degradation can be listed as follows 1) use of fuelwood for household heating and cooking 2) slash-and-burn and 3) illegal logging. The First National Forest Plan (1973-1978) focused on reforestation of denuded forests land primarily for fuelwood production purpose.The main species planted were *Larix kaempfri, Pinus rigida ,Pinus koraiensis, Robinia pseudoacaciaetc*. Through forestation, there was an increase in the volume of growing stock and soil quality, promoting biodiversity. The ecosystem service benefits of forests evaluated USD 126 billion for 2014 in Korea. Recently, we develop the techniques of nursery and silvicultural practice for climate change adaptation.

Email: jhs033@korea.kr

The division of forests into categories and their economic assessment, as an effective tool for sustainable forest management

Muslim Razhapbaev
Forest Research Institute of the National Academy of Sciences of the Kyrgyz Republic

Currently there is a need of economic assessment of forest from the point of view of the ecological functions which are carried out by them (raw, the environment protection, social, etc.). In the international practice there are many examples of various ways of an economic assessment of ecological functions of the forests. For example, a oxygen production role estimate by equating with expenses which arise at development in the artificial way of amount of the oxygen emitted by the forest from unit of area. The protective role of the forests is determined by the damage caused by natural disasters (mudflows, floods, avalanches) to economic objects, the farmland and also by costs of restoration of nutrients in the damaged soils. Soil protecting functions are estimated on increase in a harvest of crops. The biographical and hypothetical method and the method on travel expenses are applied to an assessment of the recreational forests.

However all these methods, are directed to an assessment only of one function and can't adequately estimate an ecological role of the forests in a complex of the functions which are carried out by them. In this regard, an important tool for the economic evaluation of the ecological role of forests represented the division of forests into categories.

Economic evaluation of forest by category and their ecological role can be an effective tool for sustainable forest management.

Email: mrajapbaev@yandex.ru

Implementation of participatory forest management

Davlatali Sharipov
Agency for forestry and hunting of republic of Tajikistan

Some introduction on forest degradation in Tajikistan. For local forest users in Tajikistan, long term land tenure rights for forests (SFF land) are missing, leading to continued degradation. Joint Forest Management (JFM) is a participatory forest management approach that allows the local population –either individuals or groups –to conclude long-term lease contracts for forest land. Together with the District State Forest Enterprises (SFEs), local forest users are assigned legal rights to manage and use forests. The harvest from the forest plots is shared between the SFE and the forest users according to a prior agreement between both parties. This provides both parties with incentives to rehabilitate degraded natural forests on State Forest Fund land over the long term.

JFM was introduced to Tajikistan in 2006 and has been adapted to the country's conditions with the support of the GIZ Regional Program on Sustainable Use of Natural Resources in Central Asia. In 2011 JFM was included in the new Forest Code of Tajikistan. For the moment, JFM is implemented in 8 districts of Tajikistan which comprises different forest types, such as Juniperus, Pistachio, Riparian and broadleaf forests. Experiences have shown that for the introduction of JFM the support of extension services is indispensable. Since the State Forest Enterprises do not yet have the capacity to provide these services, for the time being, external facilitation is necessary for the mobilization of JFM.

The application of Joint Forest Management is a key issue under the Forest Sector Development Strategy of Tajikistan (pending approval of the Government): 40000 ha of forests will be allocated to at least 3500 households by the year 2030, using the JFM approach.
According to the Forest Code (2011, Article 45-49) and the provision on Joint Forest Management, a JFM contract can be issued for 20 years. Long-term management- as well as annual plans, indicating the forest management activities to be undertaken by the forest user and the State Forest Enterprise (SFE), as well as the amount of forest products that can be sustainably harvested from the forest plot, are mandatory elements under the JFM contract.

JFM has been successfully applied in all forest types of Tajikistan. Plot sizes and incentives provided to the forest user will vary in order to ensure sufficient income generation from the first year of the contract.

Email: davlatali_sharipov@mail.ru

Forest restoration of foothills of Uzbekistan:
from the pistachios demonstration plantation to a government regulation

Evgeniy Botman
Republican Scientific Production Centre for Decorative Gardening and Forestry, Republic of Uzbekistan

There are 3 million hectares of rainfed land on belt of 650 - 1200 m. asl in Uzbekistan. This land used as pasture and cereal crops. Grain harvest is low and unstable, pastures due to overgrazing faced desertification. Climate changes are increasing risks of such land uses.This land is pistachio's habitat. Economic analysis shows advantage of using the land for the growing of varietal pistachio plantations in comparison with other land use. Scientists have developed guidelines for pistachio establishment plantations, their grafting and caring. However, these skills were not needed and not familiar for wide audience. In collaboration with GEF Small Grants Program strategy of "growth points" has been developed. "Growth point" is farm with varietal pistachios collection, zoning planting, mother and industrial plantation. Existence such farms convinces people in reality creation rainfed varietal pistachio plantations. As result, in Jizzakh region was created such "point" and is creating in Tashkent region. Since 2009, it was established 250 hectares of pistachio plantations with SGP help. It started independent creation of such plantations by farmers. This activity has stimulated emergence of Forestry Main Department's Regulations on creation of 8 thousand ha of pistachio plantations in next 5 years.

Email: darhanbek@yandex.com

Session H-4A (7): Future of forest industrial business: co-management of ecosystem services and corporate sustainability?

Strategic choices and corporate performance of Chinese pulp and paper industry
under the context of carbon emission mitigation

Yijing Zhang
South China Agricultural University

Under the context of climate change, carbon emission mitigation has been regarded as an effective strategy to maintain the corporate sustainability. Chinese pulp and paper industry (PPI) is undergoing a transition period from the traditional heavy polluted industry to a modern Green industry based on its possibility of clean production and use of recyclable wood materials. Enforced by restrictive regulations in recent years, the consolidation process of Chinese pulp and paper industry had cleaned up plenty of outdated small firms. However, industry restructuring and upgrading are still eagerly needed to maintain the sustainable development. Therefore, based on theories and literatures, this research firstly aims to review corporate strategic choices in coping with carbon emission mitigations from two perspectives, which are operational strategies and managerial strategies. Secondly, this research will empirically investigate corporate activities in response to carbon emission mitigation and will classify corporate development stages based on their current strategic choices from the PPI firms in China. And lastly, potential impacts of corporate strategic choices on corporate performance will be explored.

Email: yijing_becky@163.com

Effects of industrial plantations on ecosystem services and livelihoods: perspectives from China

Dalia DAmato[1], Mika Rekola[1],Minli Wan[2], Dinglin Cai[1], Anne Toppinen[1]
1. University of Helsinki
2. Jiangxi University of Finance and Economics

This paper addresses local community perceptions of changes in ecosystem services associated with rapid land use transformation in the context of plantation-based forestry. This interview-based study, conducted in southern China in 2015, aims at assessing the perceptions of local communities of: 1) the effects of Eucalyptus industrial plantations on selected ecosystem services and on local development; and 2) opportunities for future community livelihood development, based on the relations with the government and with forest industry operating locally. We analysed data from semi-structured interviews with 70 villagers for their perceptions on changes in ecosystem services after the establishment of plantations, and their future expectations on the local livelihood development. Most interviewees mentioned some negative development on environmental quality after the establishment of the industrial plantations, especially on soil and water. Interviewees' expectations for the future included receiving financial support and capacity building for household plantations and crops, support to local roads and schools, and higher employment opportunities. Even though being highly context-specific, our findings open up the discussion about the further community development opportunities in the context of plantation forestry. In particular, there is potential for developing value sharing mechanisms between the private sector and the local communities.

Email: dalia.damato@helsinki.fi

Local ecological footprinting tool (LEFT)

Peter Long
University of Oxford

LEFT can help businesses minimise the environmental impacts of their activities when making decisions about how land is used, including forested land and complex multi-functional landscapes. The tool, available at www.left.ox.ac.uk, automatically processes a series of high-quality datasets using standard published algorithms to produce maps at 30m resolution of land cover classes, numbers of globally threatened terrestrial vertebrate and plant species, beta-diversity of terrestrial vertebrates and plants, habitat fragmentation, wetland habitat connectivity, numbers of migratory species and vegetation resilience. These results are aggregated to produce a single map of relative ecological value. Our simple map interface can be used to specify an area of interest and users then receive a custom pdf report on ecologically important features in a landscape as well as a downloadable zip file containing spatial data for use in desktop GIS software.

Email: peter.long@zoo.ox.ac.uk

Tracing the ups and downs of forestry manufacturing industry by forestry products index

Xinjian Luo[1,2]; Qian Meng[3]; Shaozhi Chen[2]; Ying Liu[2]
1 Beijing Forestry University, Beijing,100083, P.R. China;
2 Research Institute of Forest Policy and Information(RIFPI), Chinese Academy of Forestry;

Beijing, 100091, P. R. China;
3 Central University of Finance and Economics, Beijing, 100091, P. R. China

Purchasing manager index of forestry manufacturing industry, Forestry Products Index(FPI) is the first composite index to signal changes in forest product manufacturing industry's trends. By observing the ups and downs of FPI, we can monitor and determine timber industry's fluctuations. In this paper, an in-depth interpretation of FPI dated from 2014 to 2015 is conducted, which reveals the overall development of forest product manufacturing industry in 2015, and forecast the short-term development trend in 2016.

Email: fulxj@sina.com

Research on weights scheme of China timber PMI based on principal component analysis

Xinjian Luo[1,2], Weiming Song[1], Qian Meng[3], Shaozhi Chen[2,] Ying Liu[2]
1 Beijing Forestry University, Beijing,100083, P.R. China;
2 Research Institute of Forest Policy and Information(RIFPI), Chinese Academy of Forestry;
Beijing, 100091, P. R. China;
3 Central University of Finance and Economics, Beijing, 100091, P. R. China

Timber PMI is praised as the barometer to signal the ups and downs of Timber industry. The weights scheme and composition of Timber PMI is the core prerequisite for its leading functions. In this paper, a deep in-depth analysis on the weights scheme of Timber PMI is conducted using data from Forestry Products Mechanism. We find that the current weight doesn't affect the leading function of Timber PMI, but it's not the optimal weighting method. A better weighting scheme is proposed in order to improve the predictive power for industry economic data.

Email: fulxj@sina.com

Biotechnology for sustainable forest intensification

Ziv Shani[1], James Zhang[2], David Zhou[2], Michael Lang[3]
1. FuturaGene Israel Ltd, Israel
2. FuturaGene Biotechnology (Shanghai), Co. Ltd.
3. Gansu FuturaGene Biotech Co. Ltd.

FuturaGene is a pioneer in the development of technologies for the sustainable intensification and the enhancement of resilience of planted forests for wood fiber production. FuturaGene is utilizing its portfolio of technologies in China to develop agro-forestry solutions which couple environmental rehabilitation with community orientated socio-economic benefits. In the North-West desert regions we have developed mass propagation systems for native yellowhorn and peony varieties and are exploring the potential of these species as sources of edible oil, biodiesel, health care products and ornamentals for urban landscaping. Our aim is to provide community-sustaining economic offtake for large scale de-desertification projects.

Email: james@futuragene.com

Session A-05 (108): Conservation, restoration and sustainable use of dryland ecosystems

Climate change and dryland ecosystems management

Pak Sum LOW , LU Qi
1. Bond University
2. Chinese Academy of Forestry

The Paris Agreement (2015) of the United Nations Convention on Climate Change (UNFCCC) (1992) aims to "strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by: (a) Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;" (Article 2).

The annual average concentration of carbon dioxide (CO_2) at the baseline station, Mauna Loa in Hawaii, has reached 400 parts per million (ppm) in 2015 compared to the pre-industrial level of 275-285 ppm, while global average temperature has already reached 1°C above pre-industrial levels. As the concentration of CO_2 keeps on rising, so is the global temperature. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (2013) projected that the global average temperature is more likely than not to exceed 2°C if the CO2 concentration reaches 538 ppm. Current UNFCCC emission reduction pledges are projected to lead to a global average temperature increase of about 3.5°C by 2100.

The profound adverse impacts of climate change are already threatening every aspect of life in our natural and human environments, including dryland ecosystems that also provide various important services, such as provisioning, regulating, cultural and supporting services. The increase in global and local temperatures is projected to drive the dryland areas even drier, which, in turn, will further affect the soil structures and nutrients balance, and hence the agricultural productivity of the dryland areas, as well as the livelihood of the people who live in these areas.

This presentation reviews the ecosystem services provided by dryland areas, and the impacts of climate change on these ecosystem services, with a special focus on dryland ecosystems management in China, including its plans and efforts to fulfil the Sustainable Development Goal 15.3 that "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world."

Given the expansive and extensive dryland areas in China, and different areas may have regional or sub-regional variations, much scientific research is still needed so that effective policy can be developed for managing the ecosystems of respective dryland areas.

Water use strategy of two willow in semi-arid alpine sandy land, Tibetan Plateau

Zhu Yajuan[1], Wang Guojie[2]
1. Institute of Desertification Studies, Chinese Academy of Forestry
2. Oregon State University Agriculture Program at Eastern Oregon University, Oregon State University

Water is a limiting factor for vegetation dynamics in semi-arid alpine sandy land of the Tibetan Plateau, especially with the increasing frequency of extreme rain and drought caused by climate change. Therefore, a relatively stable water source is necessary for plant growth. The stable isotope methodology of δD, δ18O, and δ13C was used to determine main water source and long-term water use efficiency of two willow on interdune of alpine sandy land. The results showed that two willow used soil water at different depths or ground water in different seasons, depending on water availability and water use strategy. Sandy willow used ground water during the growing season and relied on shallow soil water recharged by rain in summer. Black willow used ground water in spring and summer, but relied on shallow soil water recharged by rain in spring and deep soil water recharged by ground water in fall. The long-term WUE of two willow increased during the dry season in spring. The long-term WUE was higher in sandy willow than in black willow, as the former species is better adapted to semi-arid climate of alpine sandy land. Large area willow plantation should be limited to avoid excessive consumption of ground water in alpine sandy land.

Email: zhuyj@caf.ac.cn

Sustainable and climate-resilient land management in western PRC - achievements and prospects of the GEF-PRC partnership on land degradation

Song Zengming[1],Hu Zhangcui[1,2], Liu Shirong[1,3], Ran Dongya[1,2]
1. PRC-GEF Partnership on Land Degradation in Dryland Ecosystems
2. Department of Science and Technology, State Forestry Administration
3. Chinese Academy of Forestry

Land degradation remains one of our greatest challenges today, especially in western PRC. This is not just because of the threat of desertification or wind storms – a threat made worse by climate change - but because the land remains our key resource for food production, green development, and prosperity. The livelihoods of rural people are threatened and that affects us all in turn, which requires all agencies and partners work together. The GEF-PRC Partnership on Land Degradation in Dryland Ecosystems was the first of its kind in the world and its achievements are visible because of its implementation since 2002, including: 1) established a national inter-sectoral and multi-level coordination mechanism; 2) improved institutional enabling environment using Integrated Ecosystem Management and mainstreaming it into long tern development plan; 3) carried out scientific, innovative and realistic land degradation control demonstration; 4) upscaled sustainable land management best practices. To strengthen its role of combat land degradation, the study is exploring best way by expanding the regional scope and upscaling SLM investments in selected provinces and autonomous regions. Through further demonstration and research of landscape management, payment for ecosystem services, public private partnership, ecosystem restoration, etc, the study focuses on three components 1) SLM and vegetation cover scaled-up to improve the resilience of landscapes and ecosystems to climate change; 2) Improved management of degraded lands to support rural livelihoods and green development; 3) Enhanced SLM enabling environment and capacity for scaling up of SLM in new regions.

Email: songzmgef@126.com

Comparison of windbreak effect and installation cost of sand barriers on sandy land in China

Ki-Hyung Park[1,2], Wu Bin[2], Ding Guodong[2], Zhang Yuqing[2], Qin Shugao[2], Gao Guanglei[2]
1. Forest Restoration Division, National Institute of Forest Science, Republic of KOREA
2. School of Soil and Water Conservation, Beijing Forestry University, CHINA

This study was conducted to analyze windbreak effect and installation cost of 16 types of sand barrier (plastic net) with different height (0.2m, 0.3m, 0.4m, 0.5m) and porosity (20%, 30%, 50%, 70%) to figure out the optimal condition of sand barrier installation for combating desertification. The study site is Yanchi Research Station of Shaquanwan in Ningxia Hui autonomous region of China. HOBO Weather Station was installed at 2m ahead of the center of net and in 1m intervals from 1m backward distance of the net up to 12m distance at the height of 0.2m and 1.0m above ground to measure wind speed and direction at 5 seconds intervals for 30 minutes. Surface roughness was calculated with the measured wind speed passing through each sand barrier at the height of 0.2m and 1.0m and windbreak effect was compared. 0.4m and 0.5m sand barriers were turned to be the most cost effective and windbreak efficient measure. The cost effective windbreak efficacy has shown to be impacted more by the height than porosity of the sand barrier. For areas affected by strong winds, sand barriers of 0.4m height with materials suitable for local condition would be most effective, despite the high initial cost.

Email: bear1127@gmail.com

Effect of forest stands (*Azadirachta indica*) on soil water contents during fainfall: a case study on the central dry zone of Myanmar

Jino Kwon[1,2], Chan-Beom Kim[1], Ki-Hyunf Pard[1], Yong-Suk Kim[1], Joo-Hoon Lim[1], Khaing Hsu Wai[3], Tluang Hmung Thang[3], Wai Phyoe Maung[3]
1. Forest Restoration Division, National Institute of Forest Science, Republic of KOREA
2. Department of Environment Science and Ecological Engineering, Korea University, Republic of KOREA
3. Dry Zone Greening Department, Ministry of Environmental Conservation and Forestry, Myanmar

The central region of Myanmar is a dry zone where the annual precipitation is less than 700 mm. Although many forests in this area have been degraded due to overgrazing and logging, it is difficult to expect that they would be naturally restored. This study was conducted to research the effect of forest restoration on soil water contents in the dry land. The study site is the KOICA's plantation in 2005, and AWS and soil-moisture sensor were respectively installed in the inside and outside of the study site in February 2015. Data was measured at 30-minute intervals from February 2015 to March 2016 and analyzed. The result shows that the central region of Myanmar is clearly divided in two seasons: the dry season (November to April) and the rainy season (May to October) based on the precipitation. Also, the soil moisture contents in the forest stands were clearly changed when it rains. With rainfall, the soil moisture contents were increased then started decreasing. After 15 days, the soil moisture contents became less than 5%, the similar level with the outside of the forest stands. It indicates that the forest stands hold water maximum 15 days more than the outside and can be considered as the effect of forest restoration.
Email: alp96jk@korea.kr

Session B-05 (26): Approaches for sustaining agroforestry systems and practice in Asia and Oceania

Possibility of cultivating *Andrographis paniculata* under *Emblica officinalis* trees in drylands of sub montane north western Himalayas

Sandeep Sehgal and StanzinLandol
Division of Agroforestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, India

A field experiment was conducted to determine the feasibility of intercropping *Andrographis paniculata*Nees. and *Emblica officinalis* Gaertin. at Dryland Regional Sub Station of Sher-E-Kashmir University of Agricultural Sciences and Technology of Jammu. The objectives were to study the effect of ten year old *Emblica officinalis* trees on the growth and yield of *Andrographis paniculata* and to standardize the optimum plant spacing of *Andrographis paniculata* under intercropping. The treatment details are *Emblica officinalis*+ *Andrographis paniculata* at 30 × 45 cm spacing ($T_{1)}$;at 30 × 30 cm spacing (T_2); at 45× 45 cm spacing (T_3) and *Andrographis paniculata* at 30 × 45 cm spacing without trees (T_4).The results show that due to competition among the components of the system all the intercropping treatments registered a decrease in growth and productivity parameters like fresh shoot weight, dry shoot weight, fresh root weight, compared to control (no trees) However, on practical point of view, out of the three different spacing, plant spacing of 45 cm × 45 cm was found most suitable for successful cultivation of *Andrographis paniculata*as an intercrop under *Emblica officinalis* trees.

Email: sehgals1@yahoo.com

How effective are on-farm pro-conservation management strategies for preserving ecosystem services in Asia?

Jessica Thorn, David Bentz, Kathy Willis, Gillian Petrokofsky
University of Oxford

While a large number of studies claims to show the positive effects that maintenance of ecosystem services can have on meeting future food demand by making farms more sustainable, productive and resilient, there has been no coherent synthesis and review of the evidence to test these claims and provide an evidence base that is fit-for-purpose for policy and practice. Results are discussed of a collaborative project to produce a systematic map of the published and grey literature. The systematic map comprises a database of 746 studies and an interactive map that bring together a previously fragmented and multidisciplinary literature base that provide evidence of a wide range of conservation land management practices impacting key ecosystem services. This paper draws particularly on evidence from Asia for agroforestry, comprising 9% of the studies, which was one of the most commonly studied of the 19 conservation land management practices considered in the project. Of the 65 tree crops studied, coffee and cacao were most commonly studied, while 61% of studies measured fruit crops. A total of 109 studies considered multistorey cropping for multiple purposes such as food; fruit; fodder; ornaments; timber; shade; fuel wood; cosmetics; teeth brushing; oil; animal hide tanning; religious purposes; latex; soil enhancement and nitrogen fixation; live fencing and windbreaks; and erosion control, while 20 assessed the multifunctional role of home gardening.

Email: jessica.thorn@zoo.ox.ac.uk

Trees and non-timber forest products in agroforestry and home gardens in SE Asia – case studies and the role of research

Bernard Dell
Murdoch University

From the author's experience, this paper addresses a range of opportunities that have emerged in agroforestry in the region through investment in research and extension. It also raises connectivity between forest dependent communities and future income generation through agroindustry. Examples are discussed ranging from reclamation of abandoned agricultural land, to social and environmental benefits of urban home gardens, to the sustainability of rural upland villages, and to the domestication of valuable trees in order to illustrate the role of research in capturing data and providing options for smallholders in a diverse region. (Bernard Dell, Murdoch University, Trees and non-timber forest products in agroforestry and home gardens in SE Asia – case studies and the role of research)

Email: B.Dell@murdoch.edu.au

Introduction of *Camellia Oleifera* and study of the seedlings propagation technology

Yuan Ting-ting, Zhong Qiu-ping, Cao Linqing, Yan Chao, Yuan Ya-qi, Guo Hong-yan
Experimental Center for Subtropical Forestry, Chinese Academy of Forestry

In order to give an overview of China's exclusive wood edible oil tree *Camellia Oleifera* Abel, this article introduces its distribution area, biological characteristics, economic value, main varieties of practice and its product "*C. oleifera* oil" and its social status as a key sector to China's grain and oil security.

Meanwhile some researches regards to *C. oleifera* seedlings breeding that have been conducted and currently under implement are introduced. Also this article introduces the bud-stock grafting technology, grafted healing process, light medium formula design, plant growth regulator application, industrial breeding technology, daily management of these seedlings of *C. oleifera* propagation. Specifically presents using paraffin sections and microscopic observation system to study the effect of plant growth regulators on the healing progress of the bud-stock grafted unions of *C. oleifera* and the results that plant growth regulators can significantly promote the healing progress, the form of the callus and the connect of stock and sciontotally only when these methods are combined and carried out properly, high survive rate and good quality seedlings can be gained.

Finally some achievements obtained by our research team are summarized and some suggestions are proposed to give some guidance for the development of *C. oleifera* seedlings breeding.

Email: 458276698@qq.com

Continuous fertilization time indicates different effect on forest carbon stocks: evidence from Phyllostachys pubescens forest in subtropical southern China

Shi Lei, Liu Shirong, Fan Shaohui, Qi Lianghua, Liu Guanglu
State Forestry Admininstration Key Laboratory for Science & Technology of Bamboo & Rattan, International Center for Bamboo and Rattan

Fertilization can contribute to attempt to reduce CO2 in the atmosphere. However, the fertilizing effect on carbon (C) sequestration in the biomass is probably offset by the C release from the soil. A comparative study of the changes in C pools under different fertilization time is needed. Here, we chose Phyllostachys pubescens forest, an intensively managed forest type in subtropical southern China, to investigate the fertilization effect with different fertilization time (0, 5 and 13 years) on the C pools. After 5 years of continuous treatment, the overstory biomass C stock increased by 50%, but the effect become weak with the prolonging of the fertilization time. The fertilized effect on the C stocks of the understory, and floor litter also varied with different fertilization time; the understory decreased and then increased, and floor litter increased and then dropped. As the larger proportion of soil C in the ecosystem C pool, the change in ecosystem C was similar to soil C, which decreased and recovered again. Our results indicated that different continuous fertilization time could have different fertilizing effect on forest C pools, which can explain why fertilization experiments by different researchers have an inconsistent effect on forest C pools.

Email: leishi@icbr.ac.cn

Session C-05 (41): Eucalypt pest and disease management: challenges, and opportunities arising from new technologies

Genetic variation in *Eucalyptus camaldulensis* and *E. tereticornis* for growth and susceptibility to *Leptocybe invasa* gall wasp in China

Roger Arnold, Luo Jianzhong, Lu Wanhong, Lin Yan
China Eucalypt Research Centre, Chinese Academy of Forestry

Leptocybe invasa is a major insect pest on plantation *Eucalyptus* in many countries, with *Eucalyptus camaldulensis*, *E. tereticornis* and their hybrids having proven particularly susceptible. Variation within these species for *L. invasa* susceptibility was assessed in trials in Guangdong, China, containing 244 seedlots representing 16 natural stand and 4 seed orchard sources. Sub-specific taxa within *E. camaldulensis* differed significantly in *L. invasa* susceptibility but not growth. In *E. tereticornis* regions of origin and seed sources within regions differed significantly for both *L. invasa* susceptibility and growth. Chinese improved sources had the best growth and lowest susceptibility; Australian natural stand sources proved inferior for susceptibility and growth. Strong correlations were found between *L. invasa* susceptibility and rainfall at seed source origin within both species; seedlots from higher rainfall environments were markedly less susceptible. Differences between families for susceptibility and growth were also significant, with susceptibility proving moderately to strongly heritable. Growth and *L. invasa* susceptibility showed moderate to strongly favourable genetic correlations in both species. Our study showed that variation within species exceeded differences between species for *L. invasa* susceptibility, yet a review of published reports on *L. invasa* infestations on eucalypts showed most provide no information below the level of species.

Email: roger.arnold@y7mail.com

Comparison of *Buzura suppressaria* nuclear polyhedrosis virus purification methods

Luo Ji, Zhong Yating, Huang Huayan, Jiang Xuejian, Wu Yaojun
Guangxi Forestry Research institute, Nanning, GuangXi Province, China

Buzura suppressaria (BS) is a defoliator that causes serious harm to eucalyptus trees in the south of China every year. BS nuclear polyhedrosis virus (BsNPV) can control BS environmentally friendly. It needs to be purified to avoid other bacterias during basic and application research. To find a method with high efficiency and low cost, four methods had been used in this paper: (1) use BsNPV collected from dead body of the larvea to differential centrifugation followed by sucrose density gradient centrifugation (DGC); (2) use lysed BsNPV to cesium chloride DGC; (3) use lysed BsNPV to microfiltration; (4) BmNPV collected from dead body of the larvea deemed a kind of plasmid, use plasmid extraction kit which can extract largh plasmid to purify BmNPV genome DNA. Bacteria and BmNPV DNA were detected by PCR after genome DNA extraction. The results showed that the former two methods can't completely remove bacteria, and the band of bacteria DNA using method (1) was brighter. Method (4) could completely remove bacteria DNA but poor reproducibility. Method (3) was the only one that could achieve the purpose stably. Compared with conventional purification methods, such as chromatography, ultracentrifugation, dialysis and so on, microfiltration is an economic purification way which doesn't need advanced equipments. It is a recommended method in baculovirus purification.

Email: luoji00531ji@hotmail.com

A holistic approach is required for Eucalypt disease and insect pest management

Jolanda Roux, Michael J. Wingfield
Department of Plant and Soil Sciences, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Pretoria, South Africa

Pests and pathogens represent the greatest threat to plantation tree health globally. These two factors result in tree death and reduction in growth and yield, imparting significant negative impacts on the profitability of plantation operations. The numbers of insect pests and pathogens damaging plantation Eucalypts are continuously increasing due to accidental introductions, largely arising from anthropogenic activities such as global trade in plants and plant products. Traditionally management of insect pests and pathogens has relied on conventional selection and breeding, silviculture, biological control and/or chemical treatments. The advent of molecular techniques, and most recently the "omics" era, has contributed new tools to the tree health management arsenal. But, reliance on one or few of these tools is insufficient to ensure economically sustainable plantations. We strongly advocate a holistic approach, including all the available options for disease management. Furthermore, it is increasingly evident that an important approach to tree health management lies in global collaborations. For example, in the development and sharing of biological control agents, interrogation of genomes and improved quarantine systems.

Email: Jolanda.roux@fabi.up.ac.za

Evaluation of *Eucalyptus urophylla* provenances and progenies against leaf blight disease caused by *Coniella* sp.

Sri Rahayu
Faculty of Forestry, Universitas Gadjah Mada, Indonesia

Coniella sp. is one of the causes of leaf blight disease on *Eucalyptus urophylla* in Indonesia. It causes medium to large reddish-brown lesions which often cause the leaf tissue to desiccate and may result in defoliation and death of trees. Management of leaf blight is required using resistant genetic material. In this study weevaluated the resistance of *E. urophylla* provenances and progenies to leaf blight disease caused by *Coniella sp.* The study had the following objectives: (1) determine the genetic variation of inter provenances and families, (2) calculate the genetic correlation of the disease with height and diameter growth, (3) identify the best provenance and family based on natural and artificial inoculation tests. The progeny trial is situated in Sebulu, East Kalimantan, and consists of 183 half-sib families derived from 16 provenances. The trial was designed in a Randomized Complete Block design with six blocks as replicates, 4-tree plots of progeny in each block. Trees were planted at 3.5 x 3.5 m spacing. Results showed that variability in crown destruction by leaf blight disease was significant between families within provenances, for interaction of family blocks in the provenances, and between individual trees. Narrow sense heritability estimates for crown destruction were moderate (h2=0.53) for family, and low (h2=0.012) for individual trees. Genetic correlations between crown destruction by leaf blight disease and height or diameter growth of the trees were moderate and low, i.e., -0.53 and -0.20, respectively. Based on disease intensity, two families derived from the Tebalvalli and Wasbilla provenances respectively, were the best families with the least crown destruction intensity (16.70%).

Email: tatarahayu@yahoo.com

Novel species of *Ceratocystis* from eucalypt and taro in China

FeiFei Liu[1,2], Irene Barnes[3], Jolanda Roux[4], Michael J Wingfield[1], ShuaiFei Chen[1,2]
1. Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Pretoria 0028, South Africa
2. China Eucalypt Research Centre (CERC), Chinese Academy of Forestry (CAF), ZhanJiang, 524022, GuangDong Province, China
3. Department of Genetics, FABI, University of Pretoria, Pretoria 0028, South Africa3
4. Department of Plant and Soil Sciences, FABI, University of Pretoria, Pretoria, 0028, South Africa

The Ascomycete genus *Ceratocystis* has a broad geographical distribution and includes pathogens of a wide range of hosts, including forest trees and tuber crops. There is, however, relatively little known regarding *Ceartocystis* species, their identification, diversity, origin or impact in China. Recently, large numbers of *Ceratocystis* isolates have been collected from fresh cut stumps and wounds of *E. urophylla* × *E. grandis* trees, as well as from rotten corms of *Colocasia esculenta*(taro). The aims of this study were to identify the *Ceratocystis* species obtained from eucalypt and taro and to test their pathogenicity. Based on DNA sequence comparisons of the ITS, β-tubulin, TEF-1α, MS204 and RPBII gene regions, microsatellite data analyses, as well as morphological characteristics, these isolates were identified as two novel species. One of these species has been described as *Ceratocystis cercfabiensis* sp. nov., which is obtained from fresh stumps of *E. urophylla* × *E. grandis* (Liu et al., 2015, Antonie van Leeuwenhoek 107:1451–1473). The second species, tentatively been treated as *Ceratocystis "yunnanensis"* was obtained from black rot lesions on the corms of taro. Pathogenicity tests showed that *C. cercfabiensis* is

pathogenic on *E. urophylla* × *E. grandis*seedlings,*C. “yunanensis”* causes roe of taro corms. Further studies will consider the biology of these fungi, their genetics and their population biology.

Email: shuaifei.chen@gmail.com

Fungal biodiversity on Eucalypts in China

ShuaiFei Chen[1,3], Jolanda Roux[2], Michael J. Wingfield[3]
1. China Eucalypt Research Centre (CERC), Chinese Academy of Forestry (CAF), ZhanJiang 524022, GuangDong Province, China
2. Department of Plant and Soil Sciences, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Pretoria, 0028, South Africa
3. Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Pretoria 0028, South Africa

Approximately 4.5 million hectares of eucalypt plantations have been established in South China to meet a rapidly growing need for timber and pulp. However, the sustainable development of eucalypt plantations is under increasing threat due to pathogens. To understand the diversity and biology of fungal pathogens associated with eucalypt plantations in China, intensive disease surveys have been conducted of eucalypts in the FuJian, GuangDong, GuangXi, HaiNan and YunNan Provinces. More than 5000 fungal strains were isolated, including some well-known eucalypt pathogens. A total of 56 fungal species, including 32 new species have been identified using morphology and DNA sequence data. These fungi resided in 12 genera, including *Botryosphaeria*, *Botrytis*, *Calonectria*, *Celoporthe*, *Ceratocystis*, *Chrysoporthe*, *Lasiodiplodia*, *Mycosphaerella*, *Neofusicoccum*, *Ophiostoma*, *Quambalaria* and *Teratosphaeria*. The biodiversity of some fungi is relatively high, for example, 18 new species of *Calonectria* were identified from one area of less than 10 000 km2. Population studies of *Teratosphaeria zuluensis* indicated that it has a very high genetic diversity in China, suggesting the presence of sexual recombination in the region. Our research results have uncovered a higher than expected biodiversity of some eucalypt pathogens in China and suggest that the region may also represent the centre of origin for some.

Email: shuaifei.chen@gmail.com

Session E-05 (100): Forest restoration in hilly and mountainous landscapes: Integrating social protection and economic opportunity

Who benefits? Four decades of community-based forest landscape restoration (CBFLR) in Nepal: drivers, processes and achievements

HimlalBaral[1],KiranPaudyal[2],LouisPutzel[1]
1. Centre for International Forestry Research
2. The University of Melbourne

Widespread deforestation and land degradation has spurred global interest in forest landscape restoration (FLR) to reverse forest and biodiversity loss and mitigate climate change. Few studies, however, have evaluated FLR as an economically valuable community-based activity. This paper assesses a successful example of community-based FLR (CBFLR) in two study sites within Phewa Lake watershed, western Nepal. Through remote sensing and geographic information system analysis, land cover change over four decades is estimated. Using focus group data and transect walks, key policy drivers of successful CBFLR are analysed, and local perceptions of CBFLR-derived benefits are quantitatively assessed. Results indicate a substantial recovery of forest area on formerly degraded lands between 1972 and 2016 due to community-based conservation and forestry. National policies and legislation as well as support from government and international agencies were conducive to the implementation of CBLFR. Community members and development experts cite numerous associated benefits, including: marketable goods and services including timber, firewood and water; life sustaining services such as climate regulation, flood/erosion control, and habitat improvement; and derived values such as landscape beautification and recreational opportunities. As FLR gains traction globally, Nepal's experience with community-centered approaches contains useful insights with potential wider applied value.

Email: h.baral@cgiar.org

Case study of incorporating bamboo into landscape restoration for small holders in China: from planting trees to multi-benefits

Li Yanxia
International Network for Bamboo and Rattan (INBAR)

Commonly referred to as "poor man's gold", bamboo is a multi-use woody resource that is widely used in construction, pulping, plywood, handicrafts, and a diverse range of subsistence applications, generating job opportunities and cash income. Moreover, its vast root and rhizome system holds soil and water, serves to protect the land and prevent soil erosion, its fast growth and wide distribution in rural areas makes bamboo absorb carbon quickly into its bio-mass, compared to other sub-tropical tree species, such as Chinese Fir, thus providing the huge potential to mitigate and adapt to climate change for farmers living in remote mountainous area. The study gives eyes on how bamboo has been used in China as part of the national sloping Land Conversion Programme to rehabilitate the environment by returning unproductive agricultural land back into forests since 2001. Based on a case study from a famous bamboo town, Chishui municipal in Guizhou province, it lights the results achieved not only on the how many unproductive area restored, but most importantly on the multiple benefits achieved beyond planting bamboos -that the socio-economic and ecosystem service benefits the restoration programme has achieved in the municipal.

Email: yxli@inbar.int

Incentives for smallholder participation in forest landscape restoration (FLR) – A comparison of cases from China, Ethiopia, and Nepal

Zhang Kun
China National Forestry Economics & Development Research Center(FEDRC)

Deforestation and forest degradation in hilly and mountainous regions entails significant risks ranging from local landslides and soil impoverishment to insufficient water delivery or periodic flooding downstream. Globally, commitments to forest landscape restoration for conservation and climate change mitigation through carbon sequestration represent an opportunity to address these environmental problems. However, the economic needs of local people, including millions of upland smallholders dependent on agricultural production, are of primary concern, both in terms of the ultimate success of FLR and the immediate economic needs of agrarian populations. Through a comparison of cases – including China's Conversion of Cropland to Forest Program (CCFP), Ethiopia's forestland exclosure and participatory forest management projects and community-based FLR in Nepal – we assess the economic benefits of programs to upland smallholder landscape managers and systems for the distribution and sharing of those benefits. Through this comparison, we shed light on the role of payments and market opportunities in implementing FLR, as well as on the how institutional characteristics and arrangements from national to local levels contribute to effectiveness. Through this, we aim to inform global efforts to promote large scale restoration in smallholder-occupied landscapes.

Email: 2310165085@qq.com

Shared strengths and limitations of participatory forest management and area exclosures as landscape rehabilitation strategies in Ethiopia

Habtemariam Kassa
CIFOR

Participatory forest management (PFM) and area exclosure (AE) are two major landscape rehabilitation measures that the Government of Ethiopia is employing to rehabilitate 22 million hectares of degraded natural forest and communal land by 2025. The study examined AE and PFM initiatives and identified strengths and weaknesses. Major strength of the PFM is that the process begins with convincing communities to establish access and management norms over natural forest areas that had been under de facto open access regimes. Likewise in establishing AE, communities were actively engaged and encouraged to socially demarcate and protect degraded communal lands and manage them as per agreed up on bylaws. However, both PFM and AE exhibit some common problems: devoting less attention to meeting short and long term economic expectations of the communities as government experts often emphasized conservation goals; poorly defined responsibility and benefit sharing mechanisms; and insecure tenure over rehabilitated forests and landscapes. These limitations undermine continued engagement by communities to manage and responsibly use AEs and forests under PFM. This paper concludes the comparative analysis by identifying potential steps forward for improving both AE and PFM to more effectively restore forest lands in Ethiopia while increasing local benefits from these approaches.

Email: h.kassa@cgiar.org

How do property rights regimes provide incentives for forest landscape restoration: comparing evidence from Nepal, China and Ethiopia?

Peter Cronkleton, Louis Putzel, Habtemariam Kassa, Himlal Baral, Yustina Artati, ManiRam Banjade
Center for International Forestry Research

Forest landscape restoration (FLR) initiatives often alter tenure regimes to reclassify lands targeted for restoration, to designate legitimate forest stewards and to define acceptable land use practices, responsibilities and benefits. We compare local dynamics in Nepal, China and Ethiopia to illustrate how distinct FLR approaches changed incentives and encouraged participation. In Nepal, the 1993 Forest Act devolved communal rights over degraded forestlands to community forest user groups allowing them to invest in forest management and restoration. Autonomous user groups adapted communal management to achieve incredible restoration success, and obtained a wide range of forest goods and services. In China, where the conversion of cropland to forest program (CCFP) promoted forest restoration on cultivated sloping lands, several phases of forest tenure reform have gradually increased the rights associated with family forests. Increased tenure security and diversified management options have encouraged farmers to maintain forest cover on former agricultural lands. In Ethiopia, where participatory forest management promotes the rehabilitation of natural forests, villagers won communal access to forests, but gained only limited benefit due to restrictive management rules and ambiguous local rights. These cases compare property rights reforms, describe their practical implications and compare benefits to identify lessons for FLR.

Email: p.cronkleton@cgiar.org

Improving and scaling up exclosures as forest land rehabilitation model in Ethiopia: lessons from Tigray Region

Emiru Birhane Hizikias[1,2],Tefera Mengistu[3],Yigremachew Seyoum[3],Nigusie Hagazi[4],Habtemariam Kassa[5]
1. Mekelle University (MU)
2. Norwegian University of Life Sciences (NMBU)
3. Ministry of Environment, Forest and Climate Change (MEFCC)
4. World Agroforestry Center (ICRAF)
5. Center for International Forestry Research (CIFOR)

Exclosure is used as a means of rehabilitating degraded lands in Ethiopia. But natural processes take long in moisture deficit areas and improvements are needed to facilitate its wider use and to maximize the ecosystem services. Using selected criteria and indicators, the ecological and socioeconomic impacts of nine exclosure sites from three agroecological zones identified as successful were further evaluated. Besides FGDs and KIIs, a formal survey was administered to 324 randomly selected farmers. Institutional, legal, socio-economic aspects that influence success were identified and improvement measures were suggested. The viability of the improvement measures were evaluated ex ante. Specific technical (e.g. creating corridors that interconnect ex-closures and enhance gene flow, enriching ex-closures by planting high value species, improving survival and growth rates, diversify the products and income from ex-closures) and administrative measures (e.g. community participation in setting objectives and developing corresponding management plans, align bylaws closely with the objectives of ex-closure, clarifying use rights to improve tenure security, establish efficient monitoring system, contribution based benefit sharing mechanism) are proposed to enhance landscape productivity and ecosystem services of exclosures in Ethiopia. Enabling conditions to scaling up effective practices of exclosure were identified and used as inputs in producing a strategy document.

Email: emiru.birhane@mu.edu.et

Session F-05 (60): Forest transition pathways in Asia and Pacific

Changes in peoples livelihood in protected areas in China during a period of rapid transition

Weiye Wang
University of British Columbia

The establishment of protected areas (PA) has resulted in mixed outcomes to local people, typically by denying their access rights to nature resources. This change of rights causes a series of related changes, including related resettlement (voluntary or involuntary) and intervention programs development (such as ecotourism development) in order to reduce reliance on natural recourse and improve the well-being of local people.The phenomenon of a conservation area community affected by both resettlement and ecotourism development, present a very interesting but complex case study. How to enhance livelihood, adaptive capacity and management in the process of ecotourism development and resettlement in two protected areas in China is the research question for this study. In order to understand this question, sustainable livelihood theoretical framework combined with five capital theory, property rights theory and complex theory have been used. Photovoice and semi-structured interview methods have been used in purposive selected sampling in Jiuzhaigou Biosphere Reserve and Shennongjia National Nature Reserve in China. This research found that building capital of self-organize, empowering local community, increasing learning ability are important for improving livelihoods assets. In order to achieve better livelihoods results, participation and co-learning should be designed into adaptation policies.

Email: weiye.wang@outlook.com

Reforestation policy integration by the multiple sectors toward forest transition in the Republic of Korea

Mi Sun Park[1], Yeo-Chang Youn[2]
1. Department of Environmental Planning, Konkuk University
2. Department of Forest Sciences, Seoul National University

The Republic of Korea (ROK) achieved forest transition in the 1970s in spite of severe deforestation and forest degradation after the Korean War (1950-1953). This ROK case followed the state policy pathway to forest transition. This study interpreted the reforestation policy of the multiple sectors in ROK with the theory of environmental policy integration. ROK has attempted an integrated policy program for reforestation, land management and social development as an innovative approach to solving the problem of flood and erosion due to deforestation while pursuing economic growth. This integrated approach to reforestation of ROK was implemented in three pillars of action: 1) coordinated national plans, 2) collaboration among the governmental branches, and 3) organizational reformation. The integrative approach helped the reforestation policy to be implemented successfully. The case of policy integration for reforestation in ROK is a good example demonstrating that policy integration should be a principle of forest policy design and implementation. The Korean experience could be informative to developing countries experiencing deforestation for design and implementation of forest policy to avoid deforestation and achieve forest transition.

Email: mpark@konkuk.ac.kr

Land and forests in the Anthropocene: trends and outlooks in Asia

Wilhelmus De Jong
Kyoto University

Forest cover change is one of the defining contemporary environmental changes that validates the proposition of the Anthropocene narrative. Forest transition is a well-recognized global phenomenon, which has been studied and explained in well elaborated forest transition theory. Forest transition has been observed in over 30 countries, and it has been a trend in multiple countries in Asia. Forest transition is most relevant for the Anthropocene narrative, as it suggests that forest cover decline may eventually be followed by a forest cover increase at the global scale. The paper reviews evidence of forest transition in eight Asian countries and juxtaposes this with global forest cover trends. While it is not possible to extrapolate Asia's forest transition to the global scale, the Asian experience makes it possible to make statements on possible global forest cover scenarios. Ultimately, forest transition theory in general, and the experience of forest transition in Asia also supports the concept and related narrative of the Anthropocene.

Email: dejongwil@gmail.com

Economic globalization, trade and forest transition-the case of nine Asian countries

Li Lingchao[1,2], Liu Jinlong[2], Long Hexin[2], de Jong Wil[3], Yeo-Chang Youn[4]
1. Beijing Forestry University
2. Renmin University of China
3. Kyoto University
4. Seoul National University

Previous studies have mostly focused on the links between the variability of trade of primary sector products and forest transition. This study more widely discusses the effects of economic globalization on forest transition, and explores the links between trade, adjustment of trade structure, FDI and forest transition in nine Asian countries. The study also expands the scope of forest transition study and integrates the analysis of both forest quantity and quality change in forest transition research. The result suggests that the proportion of forestry products in total exports has significantly negative effects on forest area, forest volume and forest density, while the total export value has positive effects on forest area and forest density. It indicates that one country or region may improve forest resources condition through upgrading the export structure by absorbing FDI in manufacturing and service sectors to develop export-oriented manufacturing and service industries. This study demonstrates the need to introduce forest quality analysis in forest transition study. It also indicates that when exploring the relationship between economic globalization and forest transition, one should consider the overall situations how one country participates in economic globalization and the development and adjustment of its industries in the process of economic integration.

Email: ytlilingchao@126.com

Identification of drivers of forest transition through artificial neural network: a case study of western Indian Himalaya

Jawaid Ashraf[1], Amrender Kumar[2], Rajiv pandey[3], Wil de Jong[4]
1. Forest Research Institute
2. Indian Agricultural Research Institute

3. Indian Council of Forestry Research and Education
4. Kyoto University

Forest transitions (FT) has been analysed in many countries over last few decades. However, very few assessments have been conducted at sub-national level. The absence of such study refrain policy makers to streamline the intricacies of forest conservation and management at regional level. The present study fills this gap by identifying the potential drivers of forest transition by analysing data covering the period 1990 to 2014 of Western Indian Himalaya. In this study, an attempted has been made to identified important drivers of forest transition in this region using artificial neural networks (ANNs) approach. Among the 29 potential drivers, stepwise variables selections were performed and identified the various significant drivers. These drivers were current fallow, net area sown, livestock population, non-available for cultivation, land under miscellaneous use, and human population. Artificial Neural Networks based prediction models have been developed taking forest cover as output variable and selected drivers as input variables. Neural network models with different hidden layers (one and two) and different number of neurons(4, 5 and 6) in a hidden layer with hyperbolic function as an activation function with varying learning rate (from 0.3 to 0.8), were obtained and selected the best architecture, which having lowest mean absolute percentage error (MAPE).

The model that qualify the test statistic were selected and sensitivity analysis performed for the model priority ranking of the drivers. The sensitivity analysis suggests that livestock population is the leading driver followed by current fallow, net area sown and human population. The analysis concludes that FT in the region is due to agriculture activities, therefore, policy perspective must be orient for better management of agriculture activities to conserve forest cover.

Email: jawaid.ashraf@gmail.com

Effect of labour migration on afforestation: evidence from China

Liang Wenyuan, Liu Jinlong, Shi Weiping, Xu Tuoyuan
Renmin University of China

Forest transition research focuses on the driving forces turning round deforestation. Some researches in forest transition emphasize the importance of releasing rural population pressure on forest land. The mainly proposition is labor migration from rural to urban areas could release land pressure. In contrast, many researches highlight rural community stability in forest governance. Due to the tradeoff between labor migration and rural community stability, it requires empirical evidences to find relatively explicit conclusions. However, researches so far lack reliable data sets to prove the above proposition. And a more severe problem is the endogeneity of migration. In the econometric analysis process, we make use panel data of China in subnational level to analyse the linkage between rural population pressure and forest areas. To deal with endogenous problem, GMM method is used to correct the bias and then take the population, agricultural land and tax in 1820 of Qing Dynasty as instrument variables to get further robust estimates. Our empirical findings support the negative relationship between rural population and forest areas. Besides, labor migration from rural to urban areas could benefit afforestation holding the total population constant. The explicit policy suggestion is that providing more off-farm jobs and promoting urbanization may contribute to afforestation.

Email: lwy4965944@163.com

Conditions of forest transition in asian countries: a qualitative comparative analysis

Yeo-Chang YOUN
Seoul National University

Forest transition has been described as a sequential land use change from shrinking to expanding of forest area. There are many countries which have experienced forest decline and some of them have undergone forest transition. A number of factors including population increase and agricultural expansion among others have been considered as the driving forces for forest decline. However, there have been limited investigations on deriving forces for forest transition. This study attempted to identify the important factors which contributed or inhibited forest transition in nine countries in Asia, namely; China, India, Indonesia, Japan, Laos, Malaysia, Republic of Korea, Philippines, and Vietnam. A qualitative comparative analysis method was employed in order to understand the conditions for forest transition. Under the condition of public ownership without private forest tenure or ownership of forest land in a country, there was no case among the nine countries studied which experienced forest transition. Under the condition of non-liberal timber trade policy, there was no forest transition that occurred in the countries studied in this research. The results of analysis suggest that for forest transition to occur, the country should liberalize timber import and provide forest tenure to private sector. Based on the results of the study, in order for forest transition to take place or REDD+ to be effective, forest policy should incorporate private entrepreneurship in forest management and be aligned with timber trade policy.

Email: youn@snu.ac.kr

Comparative study on forest transition pathways of nine countries in the Asia-Pacific region

Jinlong Liu[1,] Ming Liang[2], Hexing Long[3], Lingchao Li[1], De Jong Wil[1],Youn Yaechang[1]
1. Renmin University of China
2. Kyoto University
3. Seoul National University

Forest transitions over the last three decades have attracted much academic attention. In this paper we conducted a comparative study of nine econometric models built from data covering 1960-2011 to assess variety of forest transition pathways and identify the causal factors to curve deforestation or promote reforestation in selected countries, including China, Japan, South Republic of Korea, India, Indonesia, Malaysia, Philippines, Laos and Vietnam. Using the five forest transition pathways presented by Lambin and Meyfroidt in 2010 to frame the analysis, our study finds that the economic development pathway and state forest policy pathway are most popular in these nine countries. The globalization pathway was also found to contribute to forest transitions, primarily in net forest products importer countries. The land use intensification pathway was not identified in these countries. This study also observed that countries tend to realize forest transitions at relatively low income levels, which may emanate the significance of governance in the region via forest protection law, national forest planning and afforestation programs.

Email: liujinlong_jl@hotmail.com

Differential transitional pathways of provincial forests in federal Indian polity are caused more by social than economic factors

Promode Kant
Institute of Green Economy, Gurgaon NCR, India

Despite widespread poverty India has been able to achieve transition from severe forest losses to net gain in the mid 1990s by a mix of regulatory provisions and intense forest regeneration. However, there are sharp disparities in the performance of different states wherein several states have lagged behind others by more than a decade in reaching similar transitional stages. This is despite the fact that forests and lands are administered by state governments under the umbrella of a national forest policy, broadly similar state forest laws except in tribal dominated states of north east India, and equitable allocation of central government funds across states. The paper analyses forest change matrices between 1987 to 2015 of four large and four small states in the Indian Union with varying per capita State Domestic Product, inequality indices, literacy levels, and social stresses like communal riots and immigrant influxes of these states and arrive at the conclusion that social factors predominate over economic factors in determining the forest transitional pathways within the states of the Indian Union.

Email: promode.kant@gmail.com

Session H-05 (17A), H-6A (17B), H-07 (17C): Promoting sustainable forest management through market based instrument of forest certification

A Global Overview of PEFC Forest Certification

Genevieve Chua
PEFC International

The Programme for the Endorsement of Forest Certification (PEFC) is an international non-profit, non-governmental organization dedicated to promoting Sustainable Forest Management (SFM) through independent third-party certification. PEFC works throughout the entire forest supply chain to and to ensure that timber and non-timber forest products are produced with respect for the highest ecological, social and ethical standards. Thanks to its eco-label, customers and consumers are able to identify products from sustainably managed forests.

PEFC is an umbrella organization. It works by endorsing national forest certification systems developed through multi-stakeholder processes and tailored to local priorities and conditions. With 38 endorsed national certification systems and more than 300 million hectares of certified forests, PEFC is the world's largest forest certification system.

PEFC’s forest certification system enables organizations along the forest products value chain to demonstrate responsible practices through delivering Forest Management and Chain of Custody certification. More than 300 million hectares of forests worldwide are certified to PEFC’s internationally recognized Sustainability Benchmarks, supplying more than 18,000 Chain of Custody certified companies with responsibly sourced timber and wood-based products.

Today, PEFC includes 43 national members among its membership, which is also open to international stakeholders such as civil society organizations, businesses, government entities and intergovernmental bodies. And in the workshop, we will introduce the Global Development of PEFC.

Email: gen@spicersasia.com

Forest certification in China with special reference of NWFP

Wang Wei
China Forest Certification Council

As a market based instrument to promote sustainable forest management, forest certification has been developing rapidly around the world and also in China. The China Forest Certification Scheme (CFCS) managed by the China Forest Certification Council (CFCC) has been running smoothly over several years, and in 2015 China ranked the first among all PEFC endorsed national forest certification schemes in terms of increment of certified forest areas in one year base.

The Chinese Government on one hand is very supportive to forest certification, while on the other hand also strengthens the governing and monitoring over forest certification. Apart from the Regulation on Certification and Accreditation issued in 2003, in 2015 the government issued 3 very important institutional rules over forest certification, which are Forest Certification Rules, Forest Certification Bodies' Accreditation Rules and Forest Certification Auditors' Registration Rules.

Besides regular forest management certification and chain of custody certification, CFCS also extends several others scopes of certification in the forestry sector, such as bamboo forest management certification, carbon sequestration forest management certification, forest eco-environment service management certification, forest fire control certification, and last but the most important no wood forest products management certification, and quite a number of independent correspondent certification standards have been issued.

No wood forest products management certification in China has witnessed significant progress not only for the promotion of sustainable forest management as certifying forest management is a precondition to certify NWFP management, but also for the promotion of local social and economic development and the improvement of local residences' livelihood.

Email: wang.wei@cfcs.org.cn

ITTO oerspectives: SFM and tropical forest certification

Li Qiang
International Tropical Timber Organization

ITTO is an intergovernmental organization promoting the conservation and sustainable management, use and trade of tropical forest resources. Its members represent about 80% of the world's tropical forests and 90% of the global tropical timber trade. ITTO develops internationally agreed policy documents to promote sustainable forest management and forest conservation and assists tropical member countries to adapt such policies to local circumstances and to implement them in the field through projects.

From ITTO’s perspective, SFM is the process of managing forest to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services without undue reduction of its inherent values and future productivity and without undue undesirable effects on the physical and social environment. It embraces aspects such as planning, reduced impact logging, community forestry, fire management, biodiversity, transboundary conservation, mangrove ecosystems, planted forests, as well as criteria and indicators for SFM, forest law enforcement and forest certification.

The emergence of tropical forest certification has been in response to a shift in some international tropical timber markets from the threat of bans and boycotts against tropical timber. It is a way of verifying whether a particular forest area is well managed and assuring consumers that those wood products are from sustainably managed sources.

Tropical forest certification is one of the most contentious issues in international forest policy because it is a trade-related instrument and countries feel it could influence their competitiveness and market access. In particular, tropical timber producers are concerned about their difficulties in achieving certification status and the expected increase in production costs, while market benefits look uncertain.

ITTO undertakes a wide range of policy work related to certification: it commissions studies, convenes conferences and workshops, and sustains a policy discussion among its members during the Council session. It also assists member countries in establishing their own certification programs through projects and training, such as establishment of the Indonesian Ecolabelling Institute (LEI). Meanwhile, ITTO has also developed a training package to assist training forestry staff of member countries in the application of principles, criteria and indicators for sustainable forest management and in forest auditing, which are necessary steps in the process of certification.

Email: li@itto.int

Development of national schemes in the Asia Pacific

Richard Laity
PEFC International – South East Asia Projects and Development Unit

With topics such as deforestation and climate change high on the agenda of governments, business and consumers around the world, national certification systems are being utilized to support the forest and wood products sector in the Asia Pacific. Recent years have witnessed a rapid rise in the interest and uptake of PEFC approach in the region. Through promoting forest certification, PEFC works in partnership to expand sustainable forest management while contributing to improved market access, rural development and climate change mitigation.

National forest certification systems in linewith international PEFC requirements can be found in various stages of development across in the Asia Pacific. There are over 10 million hectares of PEFC-certified forest area and 1,100 certificates in the Asia Pacific. Most countries in the ASEAN has, or is developing their own national system tailored to their specific needs and conditions. Through PEFC there is a mutual recognition mechanism whereby each national system meets the globally recognized international requirements.

As the national systems in region develop, the key challenges still facing this region, these include:The development of feasible approaches for small-forest growers and trees outside forests; group certification models which maintain financial sustainability, and; building technology to work effectively to maintain traceability across complex supply chains.

There is a host of potential opportunities for the thriving of PEFC and national forest certification systems in Asia Pacific in the near future. Developing synergies with other initiatives such as FLEGT and UNREDD, is vital, as is enhancing the recognition of certification in timber legality assurance systems (TLAS).

Email: richard@laitysforests.com

Development, operation and Impacts of Malaysian timber certification scheme

Yong Teng Koon
Malaysian Timber Certification Council

The paper briefly describes the developments leading to the proposal and adoption of forest certification as a market-linked tool to promote sustainable forest management (SFM) at the international level, and the establishment of the Malaysian Timber Certification Council (MTCC) as an independent organisation to develop and operate a voluntary and independent national timber certification scheme in Malaysia.

The implementation of the Malaysian Timber Certification Scheme (MTCS) in 2001 is both a country and market-driven initiative: country-driven as it is the national commitment to ensure that the nation's rich forest resources are sustainably managed; and market-driven to take into account the growing demand for certified timber and timber products from sustainably managed forests by the international markets.

The MTCS provides assurance that timber and timber products manufactured and sold by the certified companies are sourced from MTCS-certified forests. The MTCS achieved a significant milestone in 2009 when it was endorsed by the Programme for the Endorsement of Forest Certification (PEFC) and was subsequently recognized by the public and private timber procurement policies of a number of countries.

Forest management certification under the MTCS addresses the three pillars of sustainability covering social, economic and environmental aspects as stipulated in the Malaysian Criteria and Indicators (MC&I) for Forest Management Certification. The impacts of the MTCS and the challenges of implementing sustainable forest management and timber certification in Malaysia are also highlighted.

Indonesian forestry certification cooperation (IFCC) – PEFC branding

Dian Novarina[1], DradjadWibowo[2]
1. Director of Institutional Relations, Promotion and Marketing; Board Member of the Indonesian Forestry Certification Cooperation (IFCC)
2. Chairman of IFCC

Indonesian forests, home to some of the most biologically diverse forests in the world, is now benefiting from credible, globally recognized sustainable forest management certification following the endorsement of the Indonesian Forestry Certification Cooperation (IFCC) by the Programme for the Endorsement of Forest Certification (PEFC), the world's leading forest certification system.IFCC has developed the sustainable forest management standard since April 2012 until November 2013, and the standard was endorsed by the PEFC Council in October 2014.

The endorsement of IFCC by PEFC follows the most rigorous assessment process existing globally for national forest certification systems seeking international recognition. This process includes independent third-party evaluation, global public consultation, a review by the Panel of Experts, and consideration by the PEFC Board of Directors before PEFC members decide about the endorsement of a particular national system. The entire assessment documentation is made publicly available to ensure full transparency of the process.

On the technical ground, PEFC endorsed schemes are as credible as – and in some aspects are more credible than – other similar global certification schemes. However, PEFC is often accused as having less ability to ensure responsible forest management by certain parties.

Although fully aware of it, PEFC and their endorsed certification schemes including IFCC have their own strategy to manage such allegation. In IFCC case, IFCC implements a proactive branding and marketingstrategy. Rather than arguing about which forest certification scheme is the best, IFCC continues to encourage forest owners and companies in Indonesia to implement best practices in managing forest sustainably, to demonstrate their good practices through certification and to regain the trust of the marketplace that has been lost over the past decade. Indonesia recognizes the importance of sustainable forest management, and IFCC encourages buyers globally to take a second look at certified forest products from Indonesia and to reward those who are committed to safeguarding Indonesia's forest resources. IFCC also encourages forest owners, companies, and customers to have a very strong sense of identity, ownership, unity, brand loyalty and pride towards PEFC logo on the Indonesia's forestry products.

Email: novarinad@gmail.com

Certification of plantation forest products in New Zealand

Jon Tanner
New Zealand Forest Certification Association (NZFCA) & Wood Processors and Manufacturers' Association of New Zealand (WPMA)

As an export-oriented industry the New Zealand plantation forest products' sector has a longstanding record of third-party, internationally-accredited certification. FSC certification of forests and chain-of-custody is well established. Today, 1.27 million ha (70%) of the productive plantation estate is FSC certified. In addition to this, the New Zealand Forest Certification System was endorsed by PEFC in late 2015. The New Zealand Standard is an adoption of the Australian Forestry Standard (AS 4708:2013) which is the basis for the PEFC endorsed Australian Forest Certification system. The adoption of the Australian Forestry Standard reflects the close relationships between the two countries with many forest owners and wood processors operating in both.

New Zealand's processed wood products destined for domestic and overseas markets are also subject to a number of third party certification regimes monitoring stress grading and timber preservation. A NZ Government-endorsed National Timber Quality Scheme is now being put in place by industry to govern and coordinate these certification regimes with the view to providing consumers with clearer understanding of certification and thereby building consumer confidence in wood.

In the workshop, I will explain how these certification programmes fit together and how they underpin New Zealand's reputation for producing consistent quality, sustainable and legal plantation forestry products.

Email: jon@wpma.org.nz

Linking Future Forests to Communities

Macgregor Fullarton Macintosh
Sustainable Forestry Initiative(SFI)

SFI Inc. is an independent, non-profit organization that is responsible for maintaining, overseeing and improving the internationally recognized Sustainable Forestry Initiative®(SFI®) program.

Across Canada and the United States, 110 million hectares are certified to the SFI Forest Management Standard, the largest single forest standard in the world.

The SFI program's unique fiber sourcing requirements promote responsible forest management on all suppliers' lands. SFI Chain of Custody Standard tracks the percentage of fiber from certified forests, certified sourcing and post-consumer recycled content. SFI on-product labels identify both certified sourcing and chain of custody claims to help consumers make responsible purchasing decisions. SFI Inc. is governed by a three-chamber board of directors representing environmental, social and economic sectors equally.

Supporting research is a central tenet of the SFI program. We see it as a way to further the conservation value of forests and lands certified to the SFI Standards subject to SFI's fiber sourcing requirements. Our commitment to research is also evidence that SFI is more than just a standard.

In fact, SFI is the only forest certification standard in the world that requires participants to support forestry research. These activities include improving forest health, productivity and sustainability. Better management of forest resources and enhancing the environmental benefits and performance of forest products are also central to the SFI research mission.

The SFI community's forests are a living laboratory that shows how responsible management can maximize the environmental, economic and social values that matter to all of us.

Email: gregor.macintosh@sfiprogram.org

The impact of educating managers for sustainable forestry: the Sarawak experience

Hugh Bigsby, Mark Bloomberg, Ani Kartikasari
Faculty of Agribusiness and Commerce, Lincoln University, New Zealand

Forest management in the tropics is becoming increasingly complex as forest industries move towards sustainable management practices which must meet multiple objectives.Forest managers must now deal not only with profitable forest operations, but also with difficult environmental and social issues while meeting requirements for forest certification. As a result, developing the appropriate skills to successfully manage sustainable forest operations has become an important requirement for managers in the Sarawak forest sector. To meet the skill needs of forest managers in Sarawak, the Sarawak Timber Association and Lincoln University in New Zealand have developed an innovative postgraduate education programme. The programme has been running since 2006 and is now in its fourth cohort. A key question is what impact programme graduates are having on the forestry sector and what parts of the programme have contributed to improvement in forestry practices. While a number of surveys about the effect of the programme have been done for each cohort, none have been done across cohorts so as to provide longitudinal information. The purpose of this paper is to present results of a multi-cohort survey, and analyse outcomes from the programme after 10 years of operation.

Email: Mark.Bloomberg@lincoln.ac.nz

Development process and trend of forest certification in Korea

Yowhan Son
Professor of Korea University

The Republic of Korea is a member country of the Montreal Process. Korea has established the criteria and indicators for sustainable forest management at the national level and has acquired FSC forest management certification since 2006. However, as FSC certification has been implemented in Korea, some major issues such as expensive auditing costs from inviting overseas auditors and unreasonable standards that do not consider the unique conditions of forest fields began to emerge.

As voices urging an implementation of their own certification scheme reflecting the distinct characteristics of Korean forests were growing among stakeholders, the Korea Forest Certification Council (KFCC) which consists of 17 interested parties have been established. The KFCC has conducted various activities such as the development of national standards and its pilot tests since 2015, and it applied for PEFC membership in order to be endorsed by the PEFC in March 2016. And it is going to apply for the PEFC mutual recognition within this year. In this workshop, the development process and future plan of the KFCC will be introduced.

Email: yson@korea.ac.kr

Forest certification in Thailand

Pralong Dumrongthai
Royal Forest Department

Thailand by Thailand International Standard Institute (TISI) initiated Forest Certification since 2001. The first standard had declared on 2004 named "Sustainable Management Standard or TIS 14061-2004". On 2012 the standard had improved to TIS 14061-2012 and re-improved to be more consistency to Thailand context, which named "Economic Plantation Management Standard or TIS 14061-2016" which is under the process of Government Gazette (expect to declare on October 2016).

National Forest Management Standard guideline consists of 6 items:

1. Must consistency to forest policy, law and relevant forest regulation of Thailand
2. Must have land title or legality used-permission
3. Operate by Thai citizen, no any obstruct of Thai labour, people satisfy on business, no cause of pollution or trouble to local people
4. Operate cause to benefit on national and local economic, no cause to damage environmental (compare before and after of operate), operate base on theory that facilitates to forest sustainable management
5. Good planning and management, systematic, recording, suitable improvement and updated
6. No omit to conserve of national resources, environment and local biodiversity

TISI by The Federation of Thai Industries established Thailand Forest certification Council (TFCC) to operate:

1. Promote economic plantation, timber industry operator and their product have legality certify, sustainable management and certifying from international organization
2. Encourage cooperation among government, private, civil society sectors and educational institution to support economic timber certification
3. Convey technology, relevant knowledge that related to economic timber certification base on national, regional, international standard to economic timber operators
4. Provide training to build capacity of certification related to economic timber certification system to evaluation agencies and verifier
5. Provide advice and information resources on timber economic certification to related operator and public
6. Provide advice to economic timber plantation grower, industry operator on certifying sustainable economic timber management standard of national, regional and international.

Thailand registered to a member of Programme for the Endorsement of Forest Certification (PEFC) that is a flexible international standard and follow Thailand context. The Thailand standard TIS14061 will send to PEFC to endorsement.

Thailand and the European Union agreed on Thai-EU FLEGT VPA to provide timber and their product standard. Thailand established Timber Legality Assurance System (TLAS) to support FLEGT Licensing from EU on exporting timber to EU market that Thailand proceed since 2013 and expect to complete on 2020.

Email: pralong2000@hotmail.com

Vietnam forest certification scheme 2016-2020

Tran Lam Dong and Vu Tan Phuong
Vietnamese Academy of Forest Sciences (VAFS)

Vietnam is managing 10.1 million ha natural forests and 3.7 million ha forest plantations, 14.8% and 48.2% allocated to households, respectively. Nearly 50% of them, 4 million ha natural forests and 2.7 million ha plantations, are managed as production forests, which are in urgent need of being managed and certified following sustainable forest management (SFM) standards, particularly in the context of climate change and commitments on timber legality for wood industry. A target to achieve certifications for 2 million hectares by 2020 was set in the Forest Development Strategy (2006). However, to date only about 200,000 ha of forests are certified by FSC standard, mainly forests managed by state-owned companies. Vietnam was the fourth world largest wooden product exporter in 2015; export turnover increased quickly, from $1.9 to $6.9 billion between 2006 and 2015. However, there are only about 350 chain of custody (CoC) certificates for the whole country; FSC CoC certificates are dominant.

Although Viet Nam has started forest certification since 1998, focusing on development of the national standard and implementation of SFM and forest certification based on FSC standard, achievement to date is limited. To promote this process, on 12/01/2016, Ministry of Agriculture and Rural Development has issued the Decision No. 83/QD-BNN-TCLN to launch a project on SFM and forest certification in Vietnam. The main objective of the project is to establish the Vietnam Forest Certification Scheme (VFCS) in accordance with Vietnam's laws and requirements of the Program for Endorsement of Forest Certification (PEFC) with the aim to be endorsed by PEFC.

For implementation of the project, the major tasks for SFM will be development of the national standards, regulations and guidelines for FM and CoC, in accordance with Vietnam Bureau of Accrediation and PEFC standard-setting process. Major tasks for forest certification will be formulation of Vietnam Forest Certification Council (VFCC) and supporting certification and accreditation of certification bodies. In addition, activities to raise awareness and capacity building on SFM and forest certification for forest management agencies, forest owners and wood industries will be conducted. In addition, Vietnam has engaged in FLEGT VPA negotiation process with EU, so there is a need to integrate the timber legality into national certification. It is expected that the VFCS will be endorsed by PEFC and ready to operate forest certification in Vietnam by 2020.

Email: dong.tran@vafs.gov.vn | www.vafs.gov.vn

Progress of forest management and timber legality assurance verification in Myanmar

Shwe Kyaw
Chairman, Myanmar Forest Certification Committee

The establishment of the Myanmar Forest Certification Committee (MFCC) to govern the forest certification activities as a market-driven tool to promote the sustainable forest management of Myanmar's forest resources, the development and implementation of Myanmar Forest Certification Scheme (MFCS) and the Myanmar Timber Legality Assurance System (MTLAS) are briefly described in the presentation.

The components of MFCS, the standards for forest management certification and operations of MFCS and the definition and standards of legal timber, the main principle of MTLAS, the source of timber, product coverage and control procedure of the MTLAS are also mentioned.

Forest Management and Timber Legality verifications in Myanmar address the principles of sustainability and legality covering social, economic and environmental aspects involving all concerned stakeholders. The issues and challenges of implementing the forest management and timber legality verification in Myanmar are highlighted.

The legislations and regulations to manage and harvest forest resources in Myanmar has been in place. The Forest Management Units are trying to achieve the requirements of the standards set by MFCS and MTLAS with the participation of all concerned stakeholders.

Email: timcertcom@gmail.com

APP (China) forest certification: progress and prospect

Dr. Huang Wending (Deputy CEO, APP China Forestry, China)

APP (China) Forestry (ACF), as the forestry management company of APP, has planted nearly 300 thousand ha of forest plantation in nine provinces including Hainan, Guangdong, Guangxi, Yunnan and Henan in China since 1995. Five forest companies in Hainan, Guangdong and Guangxi had their plantations certified in 2011, and it was the first batch of forest companies which passed the CFCC-FM certification in China. At present, a total of 10 companies have the CFCC-FM / PEFC-FM certified with 250 thousand ha, accounting for 83% of its total managed areas and 98% of the plantation area (Guangdong, Guangxi, Hainan) where the wood is supplied to the pulp mills (Jingui and Jinhai).

Forest Certification has greatly improved the enterprise sustainable management, including social responsibility, environmental protection and raw material legality as well as traceability. Following internationally recognized best practices and certification principles, the corporate improved its enterprise's vision, mission and policies, and updated its strategy, road-map and related operations.These have benefited the corporate sustainable business, and also social development and environment.

E-mail: wending_huang@acf.com.cn

Session I-05 (68): Wood culture: merging the old with the new

The carrier of auspicious culture: chinese traditional cake moulds

Wang Laihua
Tianjin Academy of Social Sciences

Chinese traditional cake moulds are old cooking utensils for making cakes in kitchen. There are lots of sculptures or carving patterns (ornamentations) on each mould, which makes it not only a showcase of artistic expressions, but also conveys peoples' auspicious hope and wishes for life. Therefore, besides the function of tools, those old moulds tell us the relationship between wood and Chinese peoples' life. In this sense, they act as a carrier of Chinese auspicious culture and have great historical and cultural value.

This paper analyses the general characteristics of Chinese traditional cake moulds based on following five aspects: 1. The historical development and the materials selection (especially wood materials) of those moulds; 2. The usages, shapes and cultural values of those moulds; 3.The main artistic expressions of auspicious culture in those moulds; 4.The geographical distribution and cross-culture features of those moulds; 5.The Declining and the inheritance of Chinese traditional cake moulds.

Wang Laihua, Doctor of law (sociology major), senior researcher of Tianjin Academy of Social Sciences, enjoys the special allowance awarded by the government. Dr. Wang has long been engaged in studies of social sciences in China. During his part time, he collects Chinese traditional cake moulds for over 20 years. He published many papers in this field, and his book of "Chinese Traditional Cake Moulds" which published in 2015, got China Government Publishing Grant in 2014. In March of 2016, Dr. Wang was invited to join in the 2016 World Wood Day in Kathmandu of Nepal to demonstrate the folk art of Chinese traditional cake moulds.

Email: laihuawang@sina.com

The AMS radiocarbon dating and species identification of ancient timber architectures in Shanxi Province of China

Dong Mengyu[1], Zhou Haibin[2], Jiang Xiaomei[1], Lu Yun[1], Wang Weibin[3], Yin Yafang[1]
1. Wood Anatomy and Utilization Department, Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing100091, China
2. Wood Mechanics and Structure Department, Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing100091, China
3. Shanxi Supervision Station on Maintenance Quality of Traditional Construction, Taiyuan030001, China

As one of the most famous areas with sufficient forestry resources, a large group of ancient timber structures were built and quite a lot of them are still standing in Shanxi. This study examined forty-one components of twelve historical wood buildings that came from the northern, central, southern and south-eastern regions of Shanxi Province, China. Nineteen archaeological wood specimens were selected to establish accurate calendar dates of the timbers using radiocarbon analyses. The AMS 14C dates were calibrated and compared the dates with the historical records about the construction and maintenance times of the buildings. A total of forty-one sampling blocks also were identified with microscope of thirteen timber-tree genera. Furthermore, three genera of Abies, Larix and Pinus (*Subgen. Diploxylon*) were determined on a species level, viz. *Abies nephrolepis*, *Larix principis-rupprechtii* and *Pinus tabulaeformis*, according to the distribution of their specific species in the regions. Hardwoods of Populus, Quercus and Ulmus in Shanxi were used much more frequently in ancient wooden buildings. Most of the genera identified are native to the areas surrounding the buildings investigated, while others were from somewhat more distant regions. The results obtained provided valuable information concerning the lifestyle of the local population and the effects of wood exploitation on forest resources in ancient times.

Email: 1044301748@qq.com

DNA extraction and identification of DNA barcodes from ancient Chinese wooden architecture

Yu Min, Jiao Lichao, Guo Juan, Yin Yafang
Research Institute of Wood Industry, Chinese Academy of Forestry

Ancient wooden architecture is an important part of the Chinese civilization, which has ever profoundly influenced the development of architectures in other Asian countries. It is crucial to know wood species for the conservation and restoration of ancient wooden architecture. However, it is difficult to identify wood samples to the species level by the traditional method of wood identification. Therefore, it is urgent and important to found a new scientific and accurate method for identifying wood. This work reports on the development and application of methods for using DNA bar-coding for species identification of ancient wooden building materials. Two wood samples in Jinci temple, which is one of the most prominent temples in Shanxi, China, were collected. They were identified to Ulmus species (dated 156 to 208 BP) and Populus species (dated 804 to 862 BP), using the traditional method of wood identification and 14C measurements, respectively. For the species identification, DNA was extracted from both ancient wooden building materials. Moreover, the potential DNA barcode sequences were used to identify wood on the species level. The present results demonstrate the applicability of the DNA bar-coding to species identification from ancient Chinese wooden architecture.

Email:yuminwood@163.com

The artistic manifestation and utilization of wood and its finished products in Pakistan

Sagheer Ahmad
Beijing Forestry University

Beauty is inherent in nature, which has a marvelous combination of plants and flowers. Pakistan has a scarcity of timber and wood assets. Only 5% of its area is covered by forests, far from the desired level of sustainable economic progress i.e. 25%. Modern man’s activities have narrowed down the natural beauty of forests and love for plants is sinking day by day. Urbanization is spreading like a bush fire and people’s craze to move to cities is catching fire day by day. Thus forests are of significant value for the livelihood and security of millions of countryside people living around the forests. Peoples have learned different ways to utilize wood in various finished products. That utilization formulates a major source of income for the rural people and stakeholders. Astonishing wooden products are being made in Pakistan showing the extreme expertise of the craftsmen. Traditional skills are applied to wood and the resulting handicrafts are considered masterpieces of art the world over. Some areas are renowned just because of manufacturing quality lumber products. Utilization of wood in an artistic manner is a characteristic worthy to consider and the world should catch sight of it.

Email: sagheerhortii@gmail.com

Forest and culture in ancient China: three types of forest in ancient Chinese landscape paintings

Zhu Danqiong
Xidian University

The growth of a historical research on the relationship between forest and culture has become a new endeavor in recent years. Urban forest experts, environmental psychologists, planners and designers, and anthropologists are the primary strength to bring this field into a thriving and prolific stage. Forest, mountain, river, bridge, cloud, building and people, are regular elements in Chinese traditional landscape painting. In this presentation, I explore the relationship between forest and culture and I choose three traditional Chinese Landscape paintings to explore their relationship. The forests in those paintings represent three types of forest in Chinese landscape painting, namely, the immortal forest, the aesthetic forest, and landscape utopia. The immortal forest, described in the Painting of Goddess Luo Rhapsody, is a fairyland where a person might meet fairies and Gods. The aesthetic forest, depicted in the Painting Scroll of Spring Tour, shows a beautiful natural scenery where people can indulge themselves in the forest to appreciate the beauty of nature. The landscape utopia, portrayed in the Painting Scroll of Snow-covered Fishing Village and organized by elements in the real landscape but not exactly revealed any specific site or surrounding, is a forest in which a literati would take his spiritual journey and become himself. The three types of forest characterize three types of place attachment reflecting the mutual reinforcement between forest and culture.

Email: dqzhu22@xidian.edu.cn

Wood and Huqin

Guo Xiaoqin
Sichuan Conservatory Of Music

The world of the "wood" is so broad and rich. Human culture carried by "wood" or produced by “wood” is too numerous to count. "HuQin" as a category of Chinese traditional Musical Instruments like the rest of the wood instrument in the world is shaped by wood, and voiced by "wood" . The wood used for making this instrument is very wide. Many hard wood materials could be the choice, but different types of wood used and different shapes all contribute to the art and characteristics of Huqin. HuQin has been used by people to express the thoughts and feelings, and the shape and the sound plus human feelings have also touched the soul of the audience.

Email: staff@iwcs.com

A cultural approach to “Wood is good!”

Su Jinling
International Wood Culture Society

Wood as a naturally beautiful, eco-friendly, renewable biomaterial, with its simplicity and versatility has contributed greatly to human civilization. The function that wood stores carbon makes people rediscovering wood as the key to a sustainable future. The culture related to wood is a shared value towards wood including the material and spiritual wealth created by human being during the process of social and historical development. International Wood Culture Society (IWCS) together with the global wood enthusiasts , dedicates its whole efforts promotes the concept "Wood is Good!" by exploring the value and usage of wood from a cultural perspective, and provide a platform for people to appreciate wood, to study and share knowledge, experience and wisdom on wood. World Wood Day as a cultural event celebrated annually on March 21 serves the function of such platform. The unique celebration reminds us all the importance and true value of wood and to use wood responsibly in our daily life.

Email: jinling_su@126.com

Wood and human civilization---wood and art

He Tuo, Luo Jianju
Guangxi University

Early humans lived in forests, thus, the development of human civilization was inseparable from the application of wood, and as an important part of human civilization, the art had a close relationship with wood. In order to explore the relationship between wood and the development of human civilization, in the paper, the important contribution of wood to the development of art was discussed based on the two aspects---painting and sculpture. In painting, bark paintings, wood paintings, woodcuts and wood engravings, richen artistic activities of humans; In sculpture, wood carving, root carving and petrified wood sculptures, created a unique artistic form. In conclusion, wood had a profound impact to the development of art, and a promoting to the development of human civilization.

Email: 794138966@qq.com

The need to further enhance the longevity of precious in-ground native wooden artifacts, longhouse structures and poles made of naturally durable Borneo Ironwood and Cengal

Andrew Han Hoy Wong[1], Willies T.K. Chin[2], Adya P. Singh[3]
1. Universiti Malaysia Sarawak
2. Sarawak Forestry Corporation
3. SCION

Outdoor wooden structural artifacts in Malaysia have been found among the indigenous native communities within the tropical rainforest areas and serves as a notable national cultural heritage. In the past, the indigenous communities of Sarawak traditionally construct above-ground and aerial burial structures using intricately carved large round poles of naturally durable belian (*Eusideroxylon zwageri*) that has survived about 300 years in such wet tropical ground contact. The large diameter round logs of belian traditionally utilized for such structures were from typically slow-growing trees with mature heartwood. This is evidence of strong traditional experience about the extreme naturally durability of belian heartwood among the natives of Sarawak, whereby wooden longhouses erected in forest environments were traditionally constructed of this preferred wood material. While such traditional experience infers awareness among the people that the remaining Malaysian/Sarawak hardwood species fail to match the level of natural durability of belian, as is well supported by Sarawak in-ground durability field stake tests, it is also shown that belian is not totally immune to biodeterioration pressures as outdoor ground contact structures. Previous examinations of surface biodeterioration of heartwood structures of belian and a naturally durable Malaysian hardwood cengal (*Neobalanocarpus heimii*) suggests that wood

decay by soft rot, a peculiar white rot tunneling and tunneling bacteria threaten the longevity of these outdoor wooden artifacts after a lengthy duration of in-ground contact if appropriate conservation strategies (eg. supplementary soil treatments or wood treatments) to save these remnant wooden cultural structures are not considered.

Email: awong.unimas@gmail.com

Session A-06 (75): Scientific approach of forest carbon monitoring for the realization of REDD+

Effects of forest disturbance on vegetation structure and above-ground carbon in three isolated forest patches of Taita Hills

Chemuku Wekesa
Kenya Forestry Research Institute

The structure and species composition of undisturbed natural forests serve as benchmarks for understanding forest carbon storage potential for reduced carbon emissions. Even though Kenya is seeking to stabilize forest cover, reverse degradation and increase forest cover through mechanisms such as REDD+, there is relatively little information on inherent forest carbon storage potential or its response to disturbance. Comparative studies were undertaken in three remnant fragments of indigenous forests in Taita Hills, Kenya to characterize the structure and forest carbon storage potential of undisturbed, moderately and heavily disturbed sites within these forests. The sensitivity of forest carbon storage estimates to different methods of tree biomass estimation were also examined, including estimates which used DBH, tree height and wood density from extracted tree cores. Disturbance altered the forest structure, reduced species diversity and decreased the capacity of the forests to sequester carbon. The forests' capacity to sequester carbon reduced by between 9.2% and 70.7% depending on the site (forest fragment) and level of disturbance. Models with DBH and wood density gave higher quantities of carbon of between 0.9% and 44.4% for sites exhibiting different levels of disturbance. The present results suggest that disturbance had strong influence on forest structure, species diversity and carbon stocks and therefore maintaining the forests' ecological integrity over the long-term may prove difficult if the frequency and intensity of disturbance increases. Moreover, development and implementation of effective mitigation strategies to reduce carbon emissions will require the use of local biomass models since they are accurate.

Email: chemukukefri@gmail.com

Simplifying carbon monitoring in tropical rain forests - experiences from a REDD+ readiness project in Fiji

Michael Mussong[1], etareki Qaliduadua[2], Jalesi Mateboto[3], Daniel Plugge[4]
1. Eberswalde University for Sustainable Development (HNEE), Germany
2. Department of Fisheries and Forest, Research Division, Fiji Islands
3. Secretariat of the Pacific Community (SPC), Fiji Islands
4. German Agency for International Cooperation (GIZ), Fiji Islands

In an indigenous rainforest (in total 309 ha with 14 compartments) in Fiji a trial with four different logging intensities removing 15 to 80% of all trees ≥35cm dbh and one control treatment (no removals) was applied in the early 1990s. Twenty years after the intervention a detailed carbon inventory was carried out surveying 15 different carbon (sub)pools covering all living or dead biomass in systematic sample plots (n=1214) or in full enumeration (trees ≥35cm dbh; n=20272). Soil carbon was not investigated. Estimating the total carbon content of the carbon pools over the treatments shows that big trees (≥35cm dbh) are responsible for the main difference in the carbon storage. All other pools only differ slightly between the treatments. A multiple regression analysis for the 14 observed compartments shows that the total carbon storage can be estimated quite precisely (R^2=0.92) solely by the number of big trees and their average dbh or average tree volume. This result allows for a simplified and more time and cost efficient carbon monitoring for a wide range of undisturbed or differently treated indigenous forests some years after an intervention. Such a monitoring could be carried out by the indigenous forest owners themselves.

Email: mmussong@hnee.de

Classification of forest carbon stock for identification of forest degradation using Landsat data for REDD+ implementation

Yasumasa Hirata[1], Hideki Saito[1], Leng Chivin[2],Sar Sohira[2]
1. Forestry and Forest Products Research Institute
2. Forestry Administration, Cambodia

This study aims to classify forest carbon stock for identification of forest degradation using Landsat data for REDD+ implementation. We define forest degradation as a change to smaller carbon stock class for a certain period. We acquired Landsat images of Kampong Thom, Cambodia, and field survey was carried out to estimate forest carbon stock. After atmospheric correction of Landsat data, we performed object-based classification using them. Statistics on reflectance in each band of satellite data were also calculated for those objects. We made an object-based model to estimate forest carbon stock from the satellite data by multiple regression analysis using the field-based carbon stock estimate as the object variables and statistics of satellite data as explanatory variables. Forest carbon in each object was divided into three class for evergreen forest and two classes for other forest types, and classes of forest carbon stock were mapped. We identified and mapped changes to a small forest stock class using carbon stock class maps of two different dates to identify forest degradation. This approach makes it possible to introduce evaluation of loss by forest degradation in REDD+ monitoring system.

Email: hirat09@affrc.go.jp

Fallow vegetation recovery process in relation to swidden cultivation dynamics during past 14 years in a Karen village of Myanmar

Reiji Suzuki[1], Shinya Takeda[2], Nyein Chan[3]
1. Kyoto Gakuen University, Japan
2. Kyoto University, Japan
3. University of Forestry, Myanmar

Swidden cultivation is often considered a cause of deforestation and a source of carbon emission, especially under shortened fallow period. However, swidden system would be carbon-neutral or even carbon positive in certain instances, although few empirical studies have been carried out to confirm it. To understand the effect of swidden cultivation on forest ecosystems and carbon dynamics, it is necessary to reconstruct and analyze land-use histories using long-term monitoring data. In this study, we set out to reconstruct a 14-year land-use history of traditional Karen swidden cultivation in the Bago Mountains of Myanmar using a combination of field observations, GPS mapping and interviews conducted between 2002 and 2015. We overlaid boundary data of these swidden fields onto vegetation maps created from high-resolution satellite images. We then reconstructed the swidden fields' land-use histories and examined the vegetation recovery process by using a chronosequence method. In the Karen village, the average fallow period was around 12 years. Most residents preferred to open bamboo-dominated forests because bamboo is easily felled and burns well, even though tree-dominated forests with a longer fallow period could have been opened. Owing to the rapid recovery of bamboo, the felling and recovery of vegetation has now reached equilibrium.

Email: suzuki@kyotogakuen.ac.jp

Is research serving the needs of REDD+ policy development?

Timothy Boyle[1], Thomas Enters[2], Joel Scriven[1]
1. UNDP
2. UNEP

Research is a service industry, providing policy makers with the information they need to make evidence-based policy decisions. This paper examines the extent to which science has served the needs of decision makers involved in the development and implementation of REDD+ . As a results-based climate mitigation mechanism, REDD+ integrates new international processes with long-standing forest sustainability issues, which create new demands on and opportunities for science and research.

Surveys of researchers and REDD+ policy makers in the Asia/Pacific region revealed that while communication of novel research results among researchers is generally effective, communication of relevant research results to policy makers remains weak. A number of topics on which research is needed to support REDD+ policy development, but on which results are either lacking or have not been communicated to suitably to policy makers were identified.

Email:timothy.boyle@undp.org

Forest carbon stock estimation of Mongolia: case study on four different mountain forest regions

Narmandakh Ganbaatar, Byambagerel Suran, Baatarbileg Nachin, Gerelbaatar Sukhbaatar
National University of Mongolia

The larch dominating forests in Mongolia is located southern border of boreal forest in world which has the most of global carbon resource. The aim of this study is to estimate carbon stock of aboveground and belowground in forest areas in different mountain regions. Then carbon stocks of different mountain regions were analyzed. This study covers about 400 random selected plots, and more than 600 forest soil and litter samples were collected. And more than 20000 trees were measured and recorded for estimating aboveground biomass then it converted into carbon stock.

For the estimation of aboveground biomass, three different biomass allometric equations were selected. The loss of ignition method was chosen to estimate soil and litter dead organic carbon. As expected, aboveground biomass and carbon stocks of soil and litter were dissimilar among four different mountain forest regions. In total, larch dominating forests on organic soil category contain the most carbon. The average soil carbon stock amounts to 455±222.6 tons/ha yet litter contains only 24.5±2.5 tons/ha, aboveground biomass carbon contains 92.49±11.45 tons/ha. Estimating full carbon stock of forest opens a door to a new direction of the forest resource management for conservation, restoration and sustainable use of dryland ecosystems in Mongolia.

Email: Narmandakh256@gmail.com

Session C-06 (89): Preventing invasions of forest insects and pathogens

Mapping the risk of *Leptocybe invasa* in south african plantation forests under current and future climate

IlariaGermishuizen[1],BrettHurley[2]
1. ICFR
2. FABI

Since its arrival in 2007, the Blue Gum Chalcid wasp *Leptocybe invasa* has been a cause of serious concern for eucalypt growers in South Africa. Outbreaks are thought to be temperature driven, and occur during the warmer months in the warm-temperate areas and throughout the year in the warmer, sub-tropical areas. A potential distribution model was developed using the Maximum Entropy niche-based modeling (Maxent) technique. The model was also applied to future climate change scenarios to evaluate the wasp's potential distribution under future climatic conditions. Accuracy of prediction was evaluated using the area under the receiver-operating characteristic curve (AUC). Differences in the AUC between the test and training areas were used to assess the potential for model overfitting. MaxEnt generated high accuracy of prediction for L. invasa potential distribution. The small difference between test and training AUC values (AUCtraining = 0.93; AUCtest = 0.84) indicated that the model is robust. Higher probability of occurrence was observed in geographic areas with mild winters and warm springs. When applying the model to future climate change scenarios, there was a noticeable expansion of climatically optimal areas, suggesting a potential increase of the threat posed by this pest to South African eucalypt plantation forests into the future.

Email: ilaria.germishuizen@icfr.ukzn.ac.za

Predicting future rates of invasions by non-native forest insect species

Andrew Liebhold[1],EckehardBrockerhoff[2],MarkKimberley[2]
1. US Forest Service Northern Research Station
2. Scion Research

Biological invasions by forest insects and diseases represents a serious threat to forest sustainability in virtually all world regions. A key question that is important to solving this problem is how many more species are likely to establish in the future It remains unclear how past invasions deplete sources of new species, thereby dampening future invasions. We propose a model that captures the simultaneous effects of source species pool depletion and changes in pathway rates (e.g., imports) to predict numbers of future invasions. The central concept of the model is that the species abundance distribution within an invasion pathway is positively skewed. High propagule pressure of abundant species causes them to invade first, while the many less abundant species likely invade only under increased pathway volumes. We fit the model to historical invasions of true bark beetles, Scolytinae, in the USA and apply it to predict future establishments. Even though source species pools in Europe and Asia have not been depleted, the most abundant species have mostly already established. However, future increases in rates of imports counter-act the depletion effect and invasions are predicted to continue at an approximately constant rate.

Email: aliebhold@fs.fed.us

Environmental triggers and impact assessment of a new rust disease caused by Uromycladium acaciae on black wattle in South Africa

Thobile Nxumalo, Ilaria Germishuizen, Andrew Morris
Institute for Commercial Forestry Research

Black wattle (*Acacia mearnsii*) is an important plantation species in South Africa, mainly because both the timber and bark are utilizable yield products. In 2012, a new disease caused by Uromycladium acaciae, was identified in black wattle plantations. This rust fungus previously occurred in South Africa with less disease expression, but now posing a serious threat to the long-term economic sustainability of the crop. Little is known about its biology, the reasons for this new disease manifestation and likely yield losses. Therefore, a study was initiated to determine the impact of wattle rust on growth and productivity and also; to understand the environmental triggers for the disease outbreaks. Exclusion plot trials and monitoring plot trials were implemented for the purpose of this study. Tree phenology, spore dispersal and disease incidence and severity are assessed monthly together with climate variables. Disease symptoms include deformed pinnules, webbing of the pinnules caused by teliospores, defoliation, and multiple branching. To date, no tree deaths have been observed, but the aforementioned symptoms have resulted in stunted growth. This study, which is still in progress, will contribute to the knowledge required for the development of effective integrated management and adaptation strategies in a changing environment.

Email: thobile.mbatha@icfr.ukzn.ac.za

North Asian botanical gardens as tools for early detection of potentially harmful woody plant pests and diseases

NataliaKirichenko[1], MariaTomoshevich[2], YuriBaranchikov[1], MarcKenis[3]
1. Sukachev Institute of Forest SB RAS, Krasnoyarsk, Russia, nkirichenko@yahoo.com
2. Central Siberian botanical garden SB RAS, Novosibirsk, Russia
3. CABI Europe-Switzerland, Delémont, Switzerland

We inspected woody plants growing in botanical gardens in North Asia to identify poorly known foliar pests and diseases that may represent a danger for European and North American woody plants. Five biggest botanical gardens were visited in 2008-2015 and about 117 woody plant species from 14 families were inspected. In total, more than 200 insect species were found on alien plants. The richest taxonomic diversity of phyllophagous insects was recorded on plants from Salicaceae and *Rosaceae*. The majority of insect species belonged to *Hemiptera*, mainly aphids, Lepidoptera and Coleoptera. In a Far Eastern botanical garden, we observed severe declines of alien tree species from the genera *Juglans, Fraxinus* and *Pinus*, which need further attention. In Siberia, more than 100 cases of symptomatic infections (fungus-host plant associations) involving over 70 fungal species were recorded. Overall, 19 fungi species provided significant damage to European plants and deserve further investigations. We will discuss advantages and limitations of such surveys and provide recommendations for a better use of botanical gardens in early warning systems for invasive pests and diseases. The work was supported by the EU FP7 Project PRATIQUE (N: 212459), the COST Action FP1401 Global Warning and the RFBR (grant N: 15-29-02645).

Email: nkirichenko@yahoo.com

The Asia and the Pacific forest invasive species network

GaryMan[1], SunJianghua[2]
1. USDA Forest Service
2. Chinese Academy of Sciences, Institute of Zoology

The Asia and the Pacific Forest Invasive Species Network (APFSIN) has been established since 2004 in response the immense costs and dangers posed by invasive species to the sustainability of forests in Asia and Pacific. APFSIN is a cooperative alliance of the 33 members that make up the Asia and the Pacific Forestry (APFC), a statutory body of the Food and Agriculture Organization of the United Nations. The Network focuses on cooperation of member countries to detect, prevent, monitor, eradicate, and/or control forest invasive species in the Asia and the Pacific region. Specific objectives of the Network are to: 1) raise awareness of invasive species throughout the Region, 2) build capacity within member countries, 3) develop and share databases and information, 4) work together to address specific invasive species or issues that are affecting member countries, especially those that span multiple countries.
This presentation will provide an overview of the Asia and the Pacific Forest Invasive Species Network including the goals and objectives of the Network and examples of activities completed or are underway. The intent of the presentation is to stimulate possible collaboration between APFSIN and IUFRO and other appropriate organizations.

Email: gman@fs.fed.us

Identification of *Sirex noctilio* (Hymenoptera: Siricidae) using a species-specific cytochrome C Oxidase Subunit I PCR Assay

Sun Xueting, Tao Jing, Ren Lili, Shi Juan, Luo Youqing
The Key Laboratory of Beijing for the Control of Forest Pests, Beijing Forestry University

Sirex noctilio F. (Hymenoptera: Siricidae: Siricinae), a new invasive species in China, is a significant international forestry quarantine pest. Transportation of Sirex in logs, and related wood packing materials, has led to environmental damage and substantial economic loss in many countries around the world. Traditional morphological characteristics are not reliable for identification of the Siricidae family, particularly the larvae. Furthermore, specimens are frequently not in a suitable condition to permit morphological identification. The majority of damage is caused by the larval stage, which excavates galleries that can penetrate to the center of tree boles. Thus, development of a rapid, accurate, and effective molecular identification technique for S. noctilio, which does not require expert morphological knowledge, is necessary. Here, we describe a molecular identification tool based on the mitochondrial DNA gene, cytochrome Coxidase subunit I (COI). We designed a species-specific COI (SS-COI) PCR assay, which allows direct identification of S. noctilio, regardless of developmental stage. Six woodwasp species commonly found in China, *Sirex noctilio*, *Sirex nitobei*, *Sirex sp*., *Tremex fuscicornis Fabr*., *Tremex apicalis* Matsumura, and Xeris spectrum, were included in our analyses. Moreover, specimens of S. noctilio from 16 different areas were analyzed. The results demonstrate that our molecular assay is effective and accurate, regardless of developmental stage or type of specimen, consistent with use for quarantine purposes, to prevent the harmful consequences of *S. noctilio* spread.

Email: royal_kiwifruit@163.com

Causes of forest insect invasions and effects of mitigation measures

Eckehard Brockerhoff
1. Scion (New Zealand Forest Research Institute)
2. Better Border Biosecurity Collaboration, New Zealand

Invasions of forest pests are a major concern worldwide, and detections of new insect pests and pathogens are a regular occurrence in many countries. The ongoing increase in international trade is a main cause of this but our knowledge of the role of different invasion pathways, the level of propagule pressure of potential invaders, and our ability to prevent invasions are limited. Here I use a combination of information on pest detections trends, border interception data, and international trade data to examine the effects of phytosanitary measures designed to mitigate pathway risks. A case study on measures for one comparatively well-understood pathway, ISPM No. 15 (an international standard regulating treatments of wood packaging material used in international trade) was shown to be effective in reducing invasions to some extent. Although non-compliance issues may need more attention, these findings are encouraging and suggest that improvements are also possible with other high-risk pathways such as the live plant trade and “hitchhiker pests” in shipping containers. However, the effectiveness of mitigation measures may partly be overwhelmed by increases in international trade and associated propagule pressure.

Email: eckehard.brockerhoff@scionresearch.com

Effects of pine wilt disease invasion on soil properties and Masson pine forest communities in the Three Gorges reservoir region, China

Ruihe Gao
Faculty of Forestry

Pine wilt disease (PWD) has caused significant Masson pine mortality in the Three Gorges reservoir region in central China. In this study, five uniform Masson pine stand types infected by PWD were selected and surveyed on slopes and aspects with similar environmental conditions. In sites that had been infected, soil bulk density was reduced, and the difference among the groups was statistically significant ($P < 0.05$) at the 0–10 cm and 10–20 cm soil layers, but not at 20–40 cm. Other soil water–related physical properties, excluding noncapillary porosity, significantly differed among the groups in all soil layers. Additionally, the values of available phosphorus, sodium, potassium, calcium, and magnesium were higher in the invaded stands, but the total nitrogen and organic matter contents were lower. Masson pine does not become reestablished following PWD-induced mortality but is instead replaced by broad-leaved tree species. Among the 19 examined environmental variables, five were found to be significantly related with the ordination of plant community structure: Masson pine stumps, K+, capillary water holding capacity, capillary porosity, and soil water content. Among these factors, the plant community structure was principally related to MPS and K+. The findings of this study show that the outbreak of PWD has impacted Masson pine forest soil properties and altered forest community composition. The disease is negatively related with the presence of Masson pine and positively associated with that of broad-leaved tree species.

Email: gaoruihe2013@gmail.com

Study on control effect of pine wilt disease using biological control agent Smal-007 n Fujian Sanming

Zhengmin Han
Nanjing Forestry University

The strain Stenotrophomonas maltophilias Smal-007 was isolated by Nanjing Forestry University and developed as biocontrol agent for controlling of pine wilt disease. In order to verify the control effect of Smal-007 in the southern forest region of China, a large-scale experiment was performed in forest at Sanming city, Fujian province. A total of 363.6 hm2 pine forest locating at four ares of Sanming city (Meilie distric, Sanyuan distrit, Fenggang and Qingzhou distrit of Shaxian county) were used for the experiment. The Meilie distric forest is the area of 103.3 hm2 with Pinus massoniana pure forest, including 65.1 hm2 treated with the bacterial spray and 38.2 hm2 as control area. The Sanyuan distrit forest is mainly 100.0 hm2 with mixed forest of Masson pine and broad-leaved trees, including 51.7 hm2 treated area and 48.3 hm2 control area; The Shaxian Fenggang forest is 82.4 hm2 mainly with Pinus massoniana pure forest, including 56.5 hm2 treated area and 25.9 hm2 control area. The area of forest at Qingzhou, Shaxian county,is 77.9 hm2, mainly with Massonpine and broad-leaved trees, including 53.6 hm2 treated area and 24.3 hm2 control area. The forest in Melie district was sprayed by atomizing machine with Smal-007 culture at the concentration of 1.2～1.5 g/m2, while the forest in Sanyuan district and Shaxian County was sprayed by light aircraft at a concentration of of 0.6～0.7 g/m2. The spraying was performed for once at May of 2014 and 2015. The dead trees caused by pine wood nematode was was counted from June to December every year. The number of wilting and dead pine tree was significantly reduced in Melie district and Sanyuan district. The control efficiency in Meliet district was 90.9%and 100% for 2014 and 2015, respectively. The control efficiency in Sanyuan district was 93.4% and 92.7% for 2014 and 2015, respectively. Due to heavy rain soon after spraying, the control effectn Shaxian county was not as good as the last two districts. The control effeciency in Fenggang, Shaxian county was 30.5% and 69.4% for 2014 and 2015 respectively, while the control efficiency in Qingzhou, Shaxian county, was 26.7% and 20.1% for 2014 and 2015, respectively. When treated with the biocontrol Smal-07 culture, under the condition of no rain 48 hours after spraying, the pine wood disease of can be efficiently controlledin the southern forest region of China. Our result shows that the bacaterial Smal-007 biocontrol agent can be successfully used in most epidemic area of pine wood disease in China.

Email: zmhan@njfu.edu.cn

Session D-06 (70A), D-07 (70B): Forest remote sensing activities in Asia and Oceania

Forest change detection using trajectory based analysis with Landsat time series in tropical forests

Tetsuji Ota, Katsuto Shimizu, Zar Chi Win, Nobuya Mizoue, Shigejiro Yoshida
Kyushu University

Detecting forest disturbances is an important task to formulate mitigation strategies for deforestation and forest degradation in the tropics. Remote sensing data, due to their temporal dimension, supported by field measurements provide an appropriate set of tools for monitoring forest change over extensive land areas, especially for countries that lack national forest inventory data. Landsat satellite images have been widely used for quantifying forest cover change and forest change dynamics since the 1980's because of their long-term land observation record and suitable spatial resolution for forest change detection. After the opening to the public of the United States Geological Survey (USGS) Landsat archives, trajectory based analysis using the long-term Landsat time series stack (LTSS) data sets for extensive areas has become available. In this study, we investigated the applications of trajectory based analysis with LTSS for detecting forest disturbances in Myanmar and Cambodia. Since forests of Myanmar and Cambodia have been declined under human interactions in recent years, investigations on forest change detection are good representative for Southeast Asia. First, we investigated the best possible series of pre-processing protocols in the tropics. Second, we evaluated the accuracy of forest change detection using LTSS. Finally, we investigated the usage of characterized forest change information. This study indicate that using LTSS combined with the trajectory-based analysis is a possible way to conduct accurate forest change detection in tropical forests, after applying adequate pre-processing protocols. Detected forest changes are applicable to estimate disturbances from selective logging, and attribute disturbance agents and recovery condition. Thus, LTSS combined with the trajectory-based analysis can be used to construct a robust forest monitoring system in the tropics.

Email: chochoji1983@gmail.com

Aboveground biomass estimation of individual trees using small-footprint full-waveform LiDAR: a comparison of canopy structure-based and waveform-based metrics

Cao Lin, Ruan Honghua, She Guanghui
Co-Innovation Center for Sustainable Forestry in Southern China, Nanjing Forestry University

The accurate estimation of forest aboveground biomass (AGB) is critical for understanding the terrestrial carbon cycle and managing forest ecosystems. In this study, we assessed the capacity of small-footprint full-waveform (FWF) airborne Light Detection and Ranging (LiDAR) data to estimate the aboveground biomass (AGB) at individual tree level, over a planted forest (specifically focus on *Metasequoia glyptostroboides*) in the coastal region of east China. To do so, the individual tree based FWF metrics (i.e., canopy structure-based and waveform-based metrics) were extracted within delineated crowns; then the importance of FWF metrics were investigated; Finally, the estimation capability of the FWF metrics based models for AGB estimations were assessed and the accuracies of these models were evaluated. The results demonstrated that most of the FWF metrics have relatively low correlation coefficients with other metrics at tree level.

The individual tree level AGB are generally well predicted by the predictive models, using the canopy structure-based metrics and waveform-based metrics alone, or in combination. The metric of 95th percentile heights has the highest relative importance for AGB estimation among the sets of canopy structure-based metrics, and mean of height of median energy is the most important metric among the sets of waveform-based metrics.

Email: ginkgocao@qq.com

Estimation and monitoring of aboveground carbon stocks in the Terai Arc Landscape of Nepal using LiDAR data for REDD+ MRV

Yadav Prasad Kandel
WWF Nepal

Nepal is one of the REDD+ participant countries under the Forest Carbon Partnership Facility (FCPF). Nepal's Emission Reduction Program Idea Notes (ER-PIN) for the 12 districts of the Terai Arc Landscape has been included into the pipeline of Carbon Fund of the FCPF. Emission Reduction Program Document is being developed for the area. Measurement, Reporting and verification (MRV), which also include estimating forest carbon stocks and monitoring its change over time is the most important element of REDD+ process. Main objective of the study was to test the applicability of LiDAR remote sensing in forest carbon estimation and monitoring and find out the most suitable LiDAR metric for prediction of aboveground biomass carbon and modelling for the REDD+ MRV. Field inventory and LiDAR data for 150 sampling plots from the area were used to estimate forest carbon stocks in this study. The results of the study showed that LiDAR can provide very accurate estimates of the forest carbon stocks and its change over time and therefore could be the ultimate tool for REDD+ MRV in future. 75th percentile height of the LiDAR point clouds was the best predictor of the carbon explaining 74% of variation of the field estimated aboveground biomass carbon in the area (R^2= 0.74).

Email: ypkandel@gmail.com

Mangrove extraction in Gloria, oriental mindoro using LIDAR

Precious Zara, Donald Luna, Davies Ocampo, Sarena Grace Quiñones, Efren Rivera, Charmina Sejalbo, Damasa Magcale-Macandog*
University of the Philippines Los Baños

Determining the spatial location of mangroves is important in environmental management of coastal ecosystems. Mangroves serve as protection of shorelines from storms and waves. Various fauna thrive on mangroves; it serves as nursery for shrimps, crustaceans, mollusks and fishes. Through remote sensing and geographic information system, the environmental managers will be able to conduct a rapid and effective assessment that can be used as basis for habitat management plans. Light Detection and Ranging (LiDAR), a remote sensing technology that can examine the surface of the earth, has the capacity to produce high accuracy and high spatial resolution map. This study aims to determine the location of mangroves in Gloria using LiDAR and to propose a rehabilitation site for mangrove plantation in the area. There are histories of storm surge and strong typhoons in Gloria that affect several households in coastal zone. An additional layer of mangroves can serve as a protection for these threats and can lower the vulnerability of Gloria in such disasters. This study used support vector machine in extracting mangroves guided by field survey data. The classification has an accuracy assessment of 90%. The produced map clearly shows areas that lack layers of mangroves; abandoned fishponds were also classified and these are the proposed priority areas for rehabilitation.

Email: preciouszara@gmail.com

Forest coverage and change detection in China and Greater Mekong Subregion and Malaysia

Li Zengyuan, Pang Yong
Institute of Forest Resource Information Techniques

Forests play a vital role in sustainable development and provide a range of economic, social and environmental benefits, including essential ecosystem services such as climate change mitigation and adaptation. The Greater Mekong Subregion (GMS) is rich in forest resources. And the forests are undergoing rapid changes due to human activities. By using remote sensing techniques, we mapped forest cover of 2010 and 2005. Based on the map products from each country, we recoded classes into forest, nonforest, and others (include cloud, shadow, unclassified types). The forest coverage is about 50% and 44% in 2005 and 2010 respectively for the whole region. So the forest net loss is 6% from 2005 to 2010. Among the changes, Malaysia, Laos and Myanmar are leading in forest loss. Viet Nam showed slight increasing forest coverage.

Email: lizy@caf.ac.cn

Forest parameter estimation using remote sensing technologies

Pang Yong, Li Zengyuan, Meng Shili, Jia Wen
Chinese Academy of Forestry

China has a wide variety of forest types. It is challenging to make a reliable estimation of these forest biomass using geo-spatial technologies. We developed a Field-Airborne-Spaceborne (FAS) comprehensive observation method for forest biomass estimation. According to forest ecological zones of China, we carried out three FAS campaigns in the Northeast, central, and Southwest China. Airborne lidar data were collected along National Forest Inventory (NFI) plots. Then the airborne lidar data were used to estimate biomass after training by NFI plots. Then this Lidar estimated biomass was used to training satellite data for large area biomass mapping. The stratified regression tree modeling method was used. The overall estimation correlation coefficient are better than 0.8. For complex forest ecosystems like subtropical forest, we stratified the typical subtropical species into coniferous forest, evergreen broadleaf forest, and some other mixed forests. The hypersectral images were orthorectified and corrected into surface reflectance with support of Lidar DTM product. The fusion of Lidar and hyperspectral can classify dominate forest types. The lidar metrics improved the classification accuracy. Then forest biomass estimation was carried out for each dominated forest types using waveform Lidar data, which get improved than single Lidar data source.

Email: pangy@ifrit.ac.cn

Estimation of forest canopy height from TerraSAR-X/TanDEM-X data and topographic map

Zhang Wanqiu, YueC airong, Liu Xiaoying
Southwest Forest University

Forest height is a critical parameter, which discribe the quantity and quality of stand, in modeling forest volume and biomass. This paper investigated the possibility of estimating forest canopy height from TerraSAR-X/TanDEM-X polarimetric and interferometric data and topographic map in the tropical forest and the rubber plantation of Mengla in XishuangBanna, China. Due to the low penetration of X band and zero temporal baseline, the elevation produced from TerraSAR-X/TanDEM-X interferometric data could be taken as the digital surface model (DSM) containing canopy height in forest area. Meanwhile, DEM from topographic map represents the ground elevation since many elevation control points in topographic map were filed measured and eliminated vegetation structure. The research separately computed the relative heights of the surface and the ground by using the elevation of flat agriculture area after co-registering the DSM and DEM, and then retrieved forest canopy height from the difference between the relative heights of the surface and the ground. The result showed that the estimated canopy height was positively correlated to forest inventory data. It was also found that for the rubber plantation the best correlation coefficient 0.58 with 5.41m RMSE was achieved under HV polarization, and for the tropical forest area the best performance was under VH polarization with a correlation coefficient 0.48 and 4.91m RMSE.

Email: wanqiu_mou@hotmail.com

Assessment of wetland forest changes using geospatial technology in Malaysia

Mohd Azahari Faidi
Forest Research Institute Malaysia

Abstract: Information on the distribution of forests area is critical for decision-making and significant in climate stabilization, biodiversity conservation and social-related issues. Forest's mapping is very significant for the estimation and evaluation of the forest resources, carbon sequestration, and to support sustainable forest management. Wetland forest including peat swamp and mangrove plays an important role in conserving the environmental goods and services although it covers only small portion of the earth surface. Besides providing a wide range of goods and services, it also contributes to the socio-economic aspects of local communities. Monitoring the wetland forest is very essential as it gives supporting information needed to assess the distribution of this ecosystem and managing the resources. This study aims to assess the changes of Malaysian wetland forest using Landsat TM imagery as it's the cost-effective method to obtain current and reliable terrestrial information due to its widespread availability and frequency update. Two series of wetland forest of 2005 and 2010 were compared to detect changes using object-based classification method. From the results of the image classification, a total wetland forest area of Malaysia for years 2005 and 2010 are about 2,382,627.92 ha and 2,130,144.83 ha respectively. These cover about 18.1% and 16.2% of total land of Malaysia in years 2005 and 2010 respectively. There are about 252,483.09 ha (10.6%) reductions of wetland forest areas between these two dates that could be due to several factors such as a result of land development activity for agriculture purposes. The classification accuracies for both maps are 87% and 85% respectively for 2005 and 2010 images. This study indicates the importance and effectiveness of monitoring the wetland forest through the use of remote sensing technology to estimate, evaluate, and monitor mangrove forest resources, carbon sequestration, and also to support sustainable forest management.

Email: azaharifaidi@frim.gov.my

The engineering application of object-based forest change detection using high-resolution remote sensing image

Li Chungan[1], Liang Wenhai[2]
1. Guangxi University
2. Guangxi forest inventory institute

After years of extensive testing and practical applications of forest change detection of satellite image, we present in this paper an engineering procedure and method system for forest change detection based on object-oriented analysis of hi-resolution remote sensing images, which included image preprocessing, sub-compartment thematic map preparation, image segmentation and information extraction, object-oriented classification, classification output modification, change objects extraction and field work map production. The methods had no complex image calculation, were easy to learn, could be easy streamlined the operation, and non-professional person could complete one operation after the short-term training. Deal with one time image and thematic map and time images, the paper had introduced the application of this procedure and method system.

Email: gxali@126.com

Deriving disturbance regimes in forest environments using dense time series Landsat imagery

Nicholas Coops[1], Txomin Hermosilla[1],Michael A. Wulder[2], Joanne C. White[2], Yong Pang [3]
1. Integrated Remote Sensing Studio, Department of Forest Resources Management, University of British Columbia
2. Canadian Forest Service (Pacific Forestry Centre), Natural Resources Canada, 506 West Burnside Road, Victoria, British Columbia
3. Institute of Forest Resource Information Techniques, Chinese Academy of Forestry

Understanding the amount and rates of forest disturbance is critical to fully understand the impacts of a changing climate, and anthropogenic drivers on the forest resource. The recent open access to the Landsat satellite archive has enabled the development of national and global projects to monitor and report land cover change and dynamics. This has also precipitated a number of new approaches to processing these big datasets to characterize the change history of forested ecosystems. In this paper we review spectral trend analysis approaches to produce annual, cloud-free, seamless, surface reflectance, pixel-based image composites and techniques to detect forest changes, and their characterization based on temporal, spectral, and geometrical properties. We discuss the innovations around the use of this consistent data, with spatial and temporal resolutions necessary to quantify and characterize natural and anthropogenic changes, and suggest additional approaches to fuse these data with other three-dimensional forestry datasets such as airborne laser scanning. Lastly, we conclude by offering insights into the future of big geographic data processing and routine production of spatially extensive, yet fine grained, forest information products.

Email: nicholas.coops@ubc.ca

Riparian forest assessments through remote sensing in the Pacific Northwest

L. Monika Moskal
University of Washington

Rivers and the riparian forest corridor comprise a valuable freshwater ecosystem that has been altered by human activities including timber management, road building, and other land conversions. The habitats of river dependent species in the United States Pacific Northwest, in particular salmon, have often been degraded by these activities. Many salmon runs have become threatened with extinction and have been Endangered Species Act listed. New conservation planning and policies have developed around protecting freshwater habitats and restoring more natural river processes. In Washington State, timber landowners, officials from State and Federal agencies, Native tribes, and other stakeholders developed Forest Practice rules and codified a Habitat Conservation Plan with dual goals of providing regulatory surety for timber land owners and helping to recover the threatened salmon runs in forested watersheds. Conserving critical stream ecological functions and potential fish habitats throughout watersheds while managing and regulating timber harvest across the State requires accurate and up-to-date delineation and mapping of channels, tributaries, and off-channel wetlands. Moreover, the thermal loading of the streams, attenuated by forest cover shading and the large woody debris recruitment into the stream impacting water oxygen loads need to be effectively monitored. Precision forestry has turned to lidar technology for forest inventory assessments, this same technology can be further leveraged for riparian assessments. This presentation includes summary of multiple research project combining: the appraisal and delineation of off-channel and active channel water features; the assessment of leaf area index (LAI) and canopy shading, and; the quantification of large woody debris recruitment in riparian zones. Moreover, the assessment of the accuracy of the lidar is compared to other remote sensing techniques such as aerial and satellite stereo and non-stereo imagery. The work aims at assisting various agencies in monitoring effectiveness and protection efforts in both day-to-day implementation of Forest Practice rules and adaptive management.

Email: lmmoskal@uw.edu

Session E-06 (105A), E07 (105B): Interdisciplinary research to support tropical forest and landscape restoration: principles and applications of business models, impact investment, natural regeneration and climate change adaptation

Forest functional properties and ecosystem service provision from secondary wet and seasonally dry forests in Mesoamerica: implications for restoration

Bryan Finegan, Ricardo Santiago, Francisco AlvarezCalderón, Diego Delgado
Tropical Agricultural Research and Higher Education Centre (CATIE)

Natural secondary succession should make a key contribution to restoration of degraded land in Tropical America. What can functional ecology tell us about the potential of succession to restore forest landscapes We answer this question with studies from two Mesoamerican landscapes. We measured secondary forest functional properties (FPs) using weighted mean tree species trait values (CWMs), to evaluate vegetation response to environment and disturbance, vegetation effects on sites, and evaluated carbon sequestration in biomass estimated with allometric equations. Secondary forests covering abandoned pasture landscapes in seasonally dry areas show functional beta-diversity in CWM wood density and bark thickness related to the historical intensity of site use and fire.We show how these FPs also permit evaluation of forest sensitivity to climate change including increased fire frequency. On pasture landscapes in unseasonal areas secondary succession rapidly establishes forest cover with considerably more acquisitive FPs, which with taxonomic composition and above ground biomass, are strongly affected by soil variation across the landscape. Permanent plot data (>25 years) and chronosequence studies show that FPs and therefore ecosystem services of all secondary forests may vary little for decades. Therefore, if natural succession does not meet restoration objectives, socio-ecologically appropriate silvicultural measures must be developed.

Email: bfinegan@catie.ac.cr

Multiple schemes of restoring forest landscape:
lessons from Ghana's Reforestation Programme

MercyDerkyi[1], DanielKoomson[2]
1. Department of Forest Science, University of Energy and Natural Resources
2. Centre for climate change and Gender Studies, University of Energy and Natural Resources

For the past decade, Ghana took the bold steps to restore its degraded forest landscape through a national reforestation programme. The programme was driven to satisfy the three pillars of sustainability-environment, economic and social through the four interlinked objectives: 1. Restore forest cover of degraded forest reserves; 2. Address wood deficit situation to enhance GDP; 3. Create employment opportunities especially at local levels and 4.Contribute to food production.Using a secondary data from 2002-2014, this paper attempts to explore lessons from the different reforestation schemes (e.g. modified taungya system, commercial developers, FC/industry Plantations Funds etc.) and ascertain its contributions to principles and practices of forest landscape discourse at the global level.

Email: mercy.derkyi@uenr.edu.gh

Achieving landscape restoration through sustainable business models and value chains

Guillermo A. Navarro
Forest Policy and Economics

We explore necessary conditions for implementing effective landscape restoration as a country´s development option for the land use matrix, as part of the transformation towards a green economy. The analysis considers development patterns, national policies, and economic approaches and their role in this process of effective and efficient land use transformations in the agriculture, forestry, and protected areas. We conceptualize the necessary conditions for effective green transformations, possible approaches, and trade-offs required to achieve this change which, in our understanding, goes beyond the mere establishment of low carbon development, or even the achievement of greening effects through de-growth strategies in the land use matrix. This is especially so in the challenging social and economic context of the global south. We analyse the approach for promoting knowledge-intensive investments in land-use business models with a value chain approach that considers governance strengthening, transforming land uses for competitive and sustainable sources of raw materials and commodities, efficient transformation along the value chain, generation of income and employment and effective benefit sharing instruments. These transformations will produce business models with vital co-benefits, including ecological landscape restoration incorporating key adaptation and mitigation synergies, reducing vulnerability to climate change and producing social stability and well-being.

Email: gnavarro@catie.ac.cr

Make innovations on the model of property right to promote forest land restoration

Chen Shaozhi
Chinese Academy of Forestry

Apart from introducing the status quo of degraded forest lands and its rehabilitation trend in China, but also dissecting the major problems that degraded forest land restoration facing with, such as the effect & methods of governance & treatment on degraded forest lands remains to be improved, insufficient state input and difficult to attract social investment. Clarify the forest tenure reform's influences on the degraded forest lands, putting forward the political measures "on the premise of clarifying and restructuring the forest tenure, to take activation of forest lands and forest operation rights as the breakthrough, through the market allocation of property rights to innovate production organized form of forestry to channel funds from all sources into promoting degraded forest lands restoration". Meanwhile, adopt guarantee measures from the perspectives of 'Legislate, Change, Abolish, interpret' the law and regulations, establish and improve the finance and insurance services as well as improve the social service system to promote degraded forest lands restoration.

Email: chensz99@vip.163.com

Systematic approach on forest landscape restoration (FLR) at community level - a case study in Dagan village, Lingshui Li Autonomous County, Hainan Province, China

Qinglin HUANG
Institute of Forest Resource Information Techniques, Chinese Academy of Forestry

Taking Dagan village in Lingshui Li autonomous county of Hainan province in China as a case study, this report presents the systematic approach of Forest Landscape Restoration (FLR) at community level which includes identifying stakeholders, building the support for FLR, understanding the landscape mosaic and its dynamics, analyzing the driving forces, identifying the site-level options and priority sites, developing site-level restoration strategies, planning the FLR, implementing and monitoring the FLR plan. Eight landscape elements in Dagan Village were identified based on FLR: degraded primary forest, secondary forest, degraded forest land, plantation, paddy field, non-paddy cropland, pond and residential land. The patterns of forest landscape in Dagan Village in 1989, 1999 and 2009 were quantified separately by combining aerial image in 1999, world-view image in 2008, field forest inventory (sub-compartment inventory) and Participatory Rural Appraisal (PRA) in 2009. Markov models were constructed to explain and predict the dynamics of the forest landscape based on analysis of these patterns. The national forestry programs (the Natural Forest Protection Program, the Conversion of Cropland to Forest Program and the Eco-compensation Program for Non-commercial Forest etc.) were the main positive driving forces while some measures of local poverty alleviation, temporarily high prices of plantation products and lack of mechanism of Payment for Environmental Services (PES) of natural production forests were the main negative driving forces for the dynamics of forest landscape in Dagan Village.

Email: huangql@caf.ac.cn

Practices and problems in seed sourcing for forest and landscape restoration: results from a global survey

RiinaJalonen[1],MichelValette[2], David Boshier[3]
1. Bioversity International
2. University of Montpellier II
3. University of Oxford

Forest and landscape restoration efforts worldwide require large amounts of tree seed and seedlings in planting, or natural dispersal and recruitment. Forest degradation and climate change pose challenges for selecting and acquiring tree seed that is genetically diverse and suited to both current and future growth conditions on restoration sites. A global survey was conducted among restoration practitioners in October 2015 to study: (i) from where and how restoration practitioners source tree seeds and seedlings, (ii) what problems they have in this process and (iii) how they think seed availability could be improved. A total of 140 respondents from more than 50 countries completed the survey. Types of restoration projects varied along two main gradients identified by Multiple Correspondence Analysis: (i) from locally implemented conservation-oriented, to large scale production-oriented projects, and (ii) from projects with intensive vs. limited effort in selecting and sourcing seed suited to project purposes. Perceived problems regarding availability and quality of seed were fairly common and widely dispersed across these different types of projects. The results indicate gaps between currently used seed sourcing strategies and those strategies restoration practitioners would prefer. Awareness of the importance of origin and genetic quality of seed for productivity and adaptive capacity appears low in many projects, including projects that specifically aim for timber production and climate change mitigation. Evident needs and recommendations are discussed for improving seed and seedlings supply to help meet global and national targets for forest and landscape restoration.

Email: r.jalonen@cgiar.org

Building resilience forest ecosystem making community–state partnership in forest management in Nepal

Dharam rajUprety
HELVETAS Swiss Intercooperation

Nepal is becoming an exemplary country where state-community partnership becoming stronger in the forest management endeavor since 1990. Favorable state policies and regulation for community involvement in forest management resulted into 29000 community based forest management groups, managing 1.9 million ha of forest across the country. The paper analyzes the role of Community based forest management group (CBFMG) as managers and enhancers of forest ecosystem services that foster multiple livelihood opportunities for the community, and contribute to build resilient forest ecosystem. It looks at changes in quality and quantity of four

major ecosystem services: carbon stock, biodiversity conservation, watershed management, and aesthetic value of forest ecosystems. The author study how these services are managed by CBFMGs and contribute to build both social and ecological resilience in Nepal. This research is based on the data collected from 3000 local CBFMG from three different ecological zones, covering 23 districts between 2013 and 2016.

Preliminary results reveal that large parts of local forest dependent communities have achieved change in forest cover from degraded to greenery, as well enhancements, sales and profits from the sale of forest products and services. Community perceptions of forest cover change and enhancement of ecosystem services were also supported by the piloting scientific study conducted by HELVETAS Nepal in 2014-15 covering some of these study districts, which also revealed that there is an increment of forest area and enhancement of ecosystem services.

Email: dharam.uprety@gmail.com

Sustainable management of dryland eucalypt plantations for mine site rehabilitation, carbon and wood products

GeorginaKelly[1], AshleyWebb[2]
1. NSW Department of Primary Industries, 10 Valentine Ave, Parramatta NSW 2150, Australia
2. NSW Department of Primary Industries, Tamworth Agricultural Institute, 4 Marsden Park Rd, Calala NSW 2340, Australia

From 1999-2004 dryland eucalypt forest plantations were established on six open cut coal mine sites in the upper Hunter Valley in New South Wales, Australia using a range of soil amendments. Two species were planted at most sites: Corymbia maculata (all six sites) and Eucalyptus *camaldulensis* x grandis (five of the six sites). The objective of this research is to quantify the benefits of an early non-commercial thinning and pruning regime that was initiated in 2011. Potential benefits include increases in biomass production, tree and stand growth and carbon sequestration. The project includes a variety of sites that provide a valley wide perspective, making the results applicable and pertinent to a number of mines. Preliminary analyses on growth measurements conducted post-thinning in 2012 and 2014 indicate that thinning has increased individual tree growth rates and biomass (carbon sequestration), but overall stand biomass has been reduced in the thinned forests. The next step in our research, based on 2016 permanent growth plot measurements, is to provide data-driven full rotation projections on performance of species, land type and the species/land type interaction; and to assess the longer term impacts of establishment techniques and soil amendments. Nonetheless, we conclude that eucalypt plantations are a valuable component of mine site rehabilitation providing multiple benefits in the form of various ecosystem services.

Email: georgina.kelly@dpi.nsw.gov.au

Regeneration and development of native plant species in restored mountain forests, Hainan island, China

Liu Xianzhao, Lu Yuanchang
Research Institute of Forest Resource Information Techniques, Chinese Academy of Forestry

Natural regeneration was studied at 7-year-old native species regeneration sites on abandoned lands in central mountain areas of Hainan Island, off China's southern coast. Using linear sampling, 7 belt transects (each 5 m in width, with a cumulative length of 2000 m) were established and then subdivided into 400 plots (5m×5m). Plant regeneration was surveyed on each plot. For each woody species, the life stage, mature height, dispersal mode, and successional status were assessed. The regenerating woody community at the sites was found to be species-rich, with 40 species identified. However, the community was dominated by a subset of secondary forest pioneer species, such as *Liquidambar formosana*, *Aporosa chinensis*, and *Lannea grandis*, whereas a number of prominent primary forest species, such as *Castanopsis hainanensis* and *Machilus chinensis,* were almost completely absent. Clustering analysis divided the 40 species into different functional groups: those with a primarily economic function, a primarily ecological function, or both. A schematic illustration of the distribution of the 40 vegetation species over a larger area was created to show the functions and dominant status of species in the plots. This diagram can provide a clear reference for practical planning of forest rehabilitation. The results indicate that self-restoration has been successful in promoting native forest development to a certain extent, but that there is a need for management interventions in restoring vegetation species diversity and functional complexity, especially where natural successional processes are hampered by artificial or natural disturbances.

Email: lxz9179@163.com

Session G-06 (74): Forest education in a changing environment

Forest and forestry education in Japanese high schools: a historical review and present situation

Mariko INOUE, Yasuhiko Oishi
Forestry and Forest Products Research Institute

Recently human resource training of forest experts has attracted attention. We analyzed forest and forestry education in high schools based on research by referring to their historical changes and present situation. Forestry-specialized education in high schools started as training for forestry experts, especially for public employees in 1901. Vocational training in high schools has been changed to provide a foundation for future careers over the last 20 years. Now, forest and forestry education are not only a training station for experts, but also a providing place of general education. The number of forestry courses has also been decreased and diversified. There were 72 schools with 4,987 students in 2014, but contents of education were diversified. Now, 15% of graduates from these schools choose work or higher schools related to forests, and going on to higher schools has become important increasingly in these schools. To consider these situations, cooperation between forestry-related schools and other educational institutions related to forestry would be important. Forestry education in high schools has not always been standardized from the historical standpoint, but now it would be expected to attract the interest of young generations as a training institution for forest and forestry education.

Email: imariko@ffpri.affrc.go.jp

Enhancing capacity in managing forest genetic resources: teaching and learning through case studies

David Boshier[1,2], Michele Bozzano[2], Judy Loo[2], Per Rudebjer[2], Riina Jalonen[2]
1. University of Oxford
2. Bioversity International

Forest trees are long-lived species with high genetic diversity that is crucial for their survival, regeneration and adaptation. However, forest managers and conservationists are often poorly informed about the relevance of genetic aspects to population viability. Lack of understanding of forest genetic resources (FGR) constrains conservation of tree species, increases genetic risks in future generations and hinders adaptation to climate change. Current tertiary forestry education curricula show poor or no coverage of FGR issues, while biology teaching is often devoid of the social and practical realities. A vicious cycle is brewing where teaching and understanding of FGR and its relevance to conserving and using tree species—in protected areas and production landscapes—become increasingly marginalised.

We describe an approach to teaching and learning based on real data that covers practical issues in forest/tree conservation and management of global and local relevance. The Forest Genetic Resources Training Guide (http://forest-genetic-resources-training-guide.bioversityinternational.org) is modular: each module includes case studies on topics such as: developing conservation strategies for named tree species, genetic impacts of logging, and ensuring genetic diversity in farm-planted trees. Designed to promote 'FGR-friendly' decision-making, each case study provides genetic, ecological and socioeconomic information for student analysis. Background material is provided for each case study through teacher notes, PowerPoint presentations and videos. The material is flexible and easy to use in tertiary education and on-the-job training. Tested in a range of formal and informal learning situations, it has proved very popular with trainees. Use of the material by the planned Asia-Pacific Regional FGR Training Centre and other institutes should improve FGR management in the region. Modules are available in English, Spanish, French with Russian and Chinese in preparation.

Email: david.boshier@plants.ox.ac.uk

Global student perspectives on enrolling in forestry and related natural resources degree programs

Terry L. Sharik, Mark D. Rouleau, and Adam W. Wellstead
Michigan Technological University, Houghton, Michigan, USA

We surveyed students attending the IUFRO World Congress in Salt Lake City, Utah, USA, in October 2014, regarding the reasons they were attracted to majoring in forestry or related natural resource (FNR) degree programs, and conversely why they may have been hesitant to have done so. The 396 respondents were from 34 separate countries on five continents. Just over half of the respondents were non-Hispanic whites, female, and enrolled in a PhD program. Respondents as a whole rated enjoying nature as the most important factor responsible for their decision to enroll in a FNR program, followed by job satisfaction, concern for environmental problems, working outdoors, and being outdoors. The factors that caused respondents to hesitate most when deciding to enroll in a FNR program were earning potential, followed by the availability of scholarships and funding, contentious political issues and changing government policies, working conditions, and work locations. Statistically significant differences were found for several importance and hesitancy factors by region, gender, race/ethnicity, social background, and academic standing.

Email: tlsharik@mtu.edu

Forestry education and research management

Mika Rekola
Department of Forest Sciences, University of Helsinki, FINLAND

There have been radical changes in the forest sector in past decades. Some major drivers of changes are globalization of the economy, climate change, and new technologies such as IT. These drivers are shaping not only the forestry, forestry industry but forest education as well.

To get insight on natural resources education in general and forest education specifically, the IUFRO-IFSA Joint Task Force on Forest Education is executing Global Outlook on Forest Education (GOFE). The specific objectives are:
1. To analyze whether learning outcomes from forest science curricula are different from curricula focusing on natural resources in general
2. To make a comprehensive competencies gap analysis
3. To analyze the possibilities of new learning methods and approaches, for example those related to e-learning and LLL.

The core of the GOFE is competence analysis to be made with the Behavioral Event Interview (BEI) method, the approach widely in use in human resources studies. The method applies deep interviews targeting recent graduates. The results will provide interesting comparisons across countries and curricula.

The presentation will describe the process of the study and some preliminary results. The final results will publish in IUFRO 2017 anniversary congress.

Email: mika.rekola@helsinki.fi

Implications of ASEAN integration in Southeast Asian forestry education

Maria Paula Sarigumba
University of the Philippines Los Banos

The dynamism of political landscape in Southeast Asia (SEA) calls for adaptation of forestry education offered in the SEA universities. The shift to multi-polarity governance impends changes in political economy, such as trade, labor, country income, etc. The cooperation and coordination of SEA states result in policy changes such as opening of trade barriers, mobility of people, increasing demands in skills, etc. Forestry sector is not isolated in this adjustments. The new policies from the integration of the Association of Southeast Asian Nations (ASEAN) bring different opportunities as well as challenges to forestry graduates in the SEA region. Opportunities foreseen are opening of mobility of students and faculty, knowledge exchange among SEA universities, sharing of resources, amongst others. Challenges embedded in the political shift are the disparities of SEA states based on income, cultural differences, language barriers, and others. Through students, graduates and faculty surveys and key informant interviews, this paper aims to assess the implication of the ASEAN integration in forestry education, determine its impacts on the forestry students and graduates, and identify recommendations needed in by the SEA universities to adapt in the changing political setup in the region.

Email: mesarigumba@up.edu.ph

Development Strategies of Forest Disciplines in China

Sun Hongzhi
Northeast Forestry University, Harbin, China

Forest is a very important nature regeneration resources pool in the world. Forest discipline is the science of forest recognition, silviculture, management, protection and utilization. It plays a very important role in forestry universities. Today, forest science becomes more and more important in the area of climate changes, ecological construction as well as biodiversity protection. Especially in China, under the construction of first-class universities and disciplines in forest higher education faced new challenges, how to develop the forest universities and forest disciplines are the first consideration of forest higher educators in China. The contents of forest discipline and the development strategies will be discussed in the topic.

Analysis on the relation between Chinese college students' self-management and ideas of job application, and employment, taking the case of 2011 annual graduates of Nanjing Forestry University

Chen Yimin
Nanjing Forestry University

Using SEM based on the data from questionnaire survey to 663 college graduates, the paper analyzes deeply the relation between college students' self-management (self-knowledge, self-management of emotion, self-plan design, self-management of life, and management of social activity) and Ideas of Job Application, employment (opportunity, cost and satisfaction). As the result shows, self-knowledge affects employment cost and satisfaction through ideas of job application, and has positive correlation with them. Self-management of emotion has negative correlation with employment opportunity and no influence on ideas of jor application, employment cost and satisfaction. Self-management of life affects employment cost and satisfaction through ideas of job application, and has positive correlation with ideas of job application and employment opportunity, and negative with employment cost. self-plan design affects employment cost and satisfaction through ideas of job application, and has negative correlation with ideas of job application and employment opportunity, and positive with employment cost. Management of social activity affects employment cost and satisfaction through ideas of job application, and has positive correlation with ideas of job application and employment opportunity.

Email: cymcxyc@126.com

Session H-6B (87): innovation in the panel industry: outlook and concerns

Technological advancement in wood and wood based panel products

B.N.Mohanty, SujathaD, UdayD.N.
Indian Plywood Industries Research & Training Institute (IPIRTI)

Wood is the most popular building material in the world since ages. But prior to the advent of wood based panel products, the inherent disadvantages of natural timber made it less acceptable for many end use applications. As building sizes and market demands grew, the need to use wood with greater efficiency became more and more important. Today, there are dozens of wood panel products used in all genre of constructions, furniture and manufacturing. There is still ample room for growth in all panel sectors for new and improved products. To meet these spiraling requirements, innovation is the call of the hour not only for product development but also for the concerned processing technologies.

Technological innovation has proven to be the prime vehicle for the remarkable development in panel industries. This trend has accelerated in recent years with the proliferation of new products and new process technologies. The advancements in the development of plywood, particle boards and fiber boards has also witnessed a major expansion of the fibre board industry and emergence of specialized particle boards. The use of all kinds of agro residues for making particle board and fiber board has proven to be more environmental friendly.

Incremental innovations have been made in identifying the raw materials that would expand the basket of supply options, reduce production costs, diversify market applications and increase profitability through higher product values. The Research & Development (R&D) works at Indian Plywood Industries Research & Training Institute (IPIRTI) have established and amply demonstrated that bamboo could be a viable substitute of wood and several other traditional materials for housing and building constructions.

The R&D efforts at IPIRTI has enabled significant improvement in environmental footprints manufacturing efficiency and productivity in respect of various technologies.

The challenge for the future is to maintain the tempo and make appropriate choices for setting up the trajectory of technological innovations.

Email: director@ipirti.gov.in

Panel industry scenario in India

SuneeshBuxy[1], UdayD.N.[2]
1. Ministry of Environment, Forests & Climate Change (MoEF&CC), Govt. of India
2. Indian Plywood Industries Research & Training Institute (IPIRTI)

As on today Indian panel industry consists of more than 2500 mills with various capacities. A majority of these industries depend upon the plantation grown timber species viz. *Poplar sp*., *Eucalyptus sp*., Silver Oak (*Grevillea robusta*), *Melia dubia*, Rubber wood etc. which indirectly reduces pressure on natural forests and help in conservation efforts. Through the effective research by the Scientists of Indian Plywood Industries Research & Training Institute (IPIRTI) it was possible to broaden the market of some plantation products into speciality products i.e.

treated wood with enhanced dimensional stability and service life, development of quality composite panel materials like Decorative/Marine/Shuttering grade Plywood, Laminated Veneer Lumber (LVL), Compreg etc.

While India's use of Particle board and Medium Density Fibre (MDF) board still remains modest by Asian standards, a recent upswing in the economy and Government reforms, sustained economic growth over next five years would bring about changes in future. There is a trend of 15% growth annually in utilization of particle board and MDF and likely to rise as Indian architects and furniture manufacturers are to choose more modern materials rather than to stick to the traditional plywood.

A significant development towards use of non-wood raw material for panel products is the Bamboo Mat Board [BMB], Bamboo Mat Veneer Composite [BMVC], Bamboo Mat Corrugated Sheet [BMCS], Bamboo Mat Moulded Skin Board [BMMSB] made out of mats woven with bamboo slivers, Bamboo Laminates/Lumber, Particle board produced from rice husk, jute fibres, cotton stalks, Pine needle etc., and Medium density fibre board from bagasse, bamboo, Rice/Wheat straw etc. More extensive use and further improvements in these technologies can play a significant role in forest conservation besides generation of income and employment and also promoting the concept of sustainable forest management practices in the country.
The healthy growth and existence of the industry will depend on meeting the challenges successfully through implementation of innovative and adoptive technologies developed at various Research & Development organizations.

Email: director@ipirti.gov.in

Innovations in the field of adhesives for panel products

SujathaD.,MamathaB.S.,MohantyB.N.
Indian Plywood Industries Research & Training Institute (IPIRTI)

Adhesives which are backbone of any panel products play an important role from the point of view of durability as well as cost. Phenol Formaldehyde (PF) resin continues to remain the most preferred adhesive in India especially for weather resistant panel products while the Amino resins are more commonly used for all kinds of interior applications. Phenol is synthesized from petroleum and chemicals derived from natural gas. Hence the price of the phenolic resin is directly tagged to the fluctuations in the petroleum price. Materials which can replace the phenol either partially or wholly in the resin would play a defining role on the overall cost. A number of natural materials are available which in their molecular architecture resemble phenol and are capable of undergoing similar reactions. With the use of renewable natural materials IPIRTI has unveiled a new "green" adhesive which will work as an alternative to commonly used petroleum-based wood adhesives.

These natural materials are made to partially replace phenol molecules in PF resin which is being used to manufacture boiling water resistance grade plywood. These materials being indigenously available from renewable natural resources are comparatively cheaper and also eco-friendly. It has been observed that with 30 – 40% replacement of phenol in PF resin with natural material which is possible the concomitant cost reduction is in the range of 20 – 30%.

In a parallel development, the emission of formaldehyde gas from panels bonded with Urea Formaldehyde (UF) resin has been inviting serious concerns in recent years as formaldehyde is considered to pose health hazards. Keeping the above harmful effects in view, studies have been carried out at IPIRTI in order to develop UF resin using suitable scavengers that could mop up the free formaldehyde during the resin preparation.

Email: director@ipirti.gov.in

Wood-Strand sandwich panels for building & transportation applications

James Jarvis, Mostafa Mohammadabadi, Nathan White, VikramYadama
Composite Materials and Engineering Center, Department of Civil and Environmental Engineering, Washington State University

This presentation will focus on fabrication, performance, and application of wood-strand sandwich panels designed to meet the long-term goal of combining energy and structural demands of a building envelope (residential and commercial buildings account for almost 39% of the total U.S. energy consumption and 38% of U.S. carbon dioxide emissions). A wood-strand sandwich panel with a thin walled 3-D core has been developed for use in building envelopes, as well as applications where lightweight structural sandwich panels are desired (such as transportation). Underutilized timber from forest thinning or fast growing plantations are ideal for fabricating these panels. These panels have a bending stiffness that is 21% stiffer than commercial OSB, but a density of only 300 kg/m^3. The sandwich panel is significantly stiffer in bending with increased R-value while utilizing over 40% less material than typical OSB sheathing material of equal thickness. Resin consumption, which accounts for approximately 30% of the production costs in a typical composite panel plant, could be reduced by over 40%. Incorporation of insulation into the cavities of the sandwich panel significantly improves thermal properties. These high performance and lightweight sandwich panels can be utilized for prefabricating building envelopes and used for in shipping containers.

Email: jd.jarvis@wsu.edu

Panel wood industry of Bangladesh: Future scenarios applying climate change

MohammedAl-Amin
Institute of Forestry and Environmental Sciences, University of Chittagong

Bangladesh is facing and will face one major challenge in coming decades: climate change. Forest and its proper utilization may be one of the options to combat the challenge. However, according to government estimate Bangladesh possesses 1.52 million ha of forest land comprising 17.08% of total land mass of the country, cannot supply the total demand of forest wood and wood products of the country. 19 tree species, those are responsible for supplying raw materials are disappearing fast and are considered as threatened. To meet the demand of timber and wood, Bangladesh needs to maximize the production & utilization of timber and import wood from foreign countries. The projection of import in 2020 will be about 155000 m^3. On the other hand, there were 28 nos. of plywood and particle board factories in private sector, out of them 12 were now suspended their operation due to non-availability of raw materials, running capitals and laborer problem. Most of the forest product based industries owned by the government particularly by BFIDC and BCIC. Nevertheless, government is looking for privatization of these state owned mills. One of the major reasons for privatization: mills are significantly non-profitable. However, dedicated plantations for the industry to supply raw materials, using modern

technologies and putting emphasis on product development research may change the situation and sustain the growth in production of panel products of the country.

Email: prof.alamin@yahoo.com

Mechanical performance of poplar LVL (Laminated Veneer Lumber) reinforced by bamboo scrimber

Wang Zhaohui, Tian Zhaopeng
Research Institute of Wood Industry, Chinese Academy of Forestry

Poplar LVL (Laminated Veneer Lumber) is the main commercial wood product for furnitures and doors widely in China. But as for structural components poplar LVL is limited to be used for its relatively low stiffness. In this paper bamboo scrimbers were glued to the poplar LVL's surfaces to reinforce the mechanical performance of poplar LVL and the effect of different ratio of bamboo scrimber to LVL in thick direction on the mechanical performance of the composite were studied. Mechanical test including shear strength, modulus of rupture (MOR) and modulus of elasticity (MOE) of bamboo scrimber reinforced poplar LVL were carried out according to JAS 2773-2013 Standard for LVL. The results showed that increasing bamboo scrimber's thickness had a positive impact on the vertical and horizontal shear strength, MOR and MOE. While the bamboo scrimber's thickness was nearly 33% of the whole composite thickness, the increasing of the mechanical properties was obvious and optimized. Therefore, the mechanical performance of Poplar LVL can be designed to be improved in reasonable condition by controlling the thickness of bamboo scrimber to meet the requirements of structural engineering materials.

Email: zhwang@caf.ac.cn

Session B-07 (77): Conserving and utilizing of forest genetic resources in Asia and Oceania: opportunities for and benefits from regional collaboration

The new challenge of developing hybrid pine (*Pinus elliottii* × *P. caribaea*) in South China

Guo Wenbing, Zhao Fencheng, Li Zhen, Hu Jiwen, Dai Ying, Li Yiliang, Wu Huishan
Guangdong Academy of forestry

The hybrid between slash pine (*Pinus elliottii*) and Caribbean pine (*P. caribaea*) has large stem volume and high oleoresin yield, and has been one of the important commercial forests species in South China. Progress in genetic improvement of growth in the hybrid pine had been made in Guangdong by selecting fast-growing progenies. However, there are still many challenges to overcome. Firstly, the major drawback of the hybrid pine and its male parent is their lack of cold hardiness, which limiting their distribution in Central China. Since the varieties *bahamensis* and *caribaea* of *P. caribaea* exhibit better chilling hardiness than var. hondurensis, they might be preferentially used as male parent to improve the cold hardiness of the hybrid. Secondly, Low soil phosphorus (P) availability in the southern area is a major constraint to the growth of the hybrid pines. Considering the environmental problems and the overuse of phosphate rock resource caused by fertilization, P efficiency should be one of the major traits targeted for genetic

improvement of the hybrid pines in the future. Thirdly, with the increase of labor cost in clonal propagation, the use of somatic embryogenesis for propagation is an alternative in clonal forestry.

Email: wbguo@sinogaf.cn

Conserving and utilizing of forest genetic resources in South Korea

Kyu-Suk Kang[1], Sung-Joon Na[2], He-Jin Lee[1], Dae-Young Kim[1]
1. Seoul National University
2. National Institute of Forest Science

Genetically improved forest reproductive materials (FRM) have been produced from seed orchards since 1976 in Korea. All seed orchards are centrally owned, documented and managed by the Forest Seed and Variety Center. Seed orchard program was launched in 1968. From 1968 to early 1980s, conifer seed orchards had mainly been established by grafts and cuttings from selected plus trees. From early 1980s up to now, seed orchards of deciduous species have been established for seed production and ex situ gene conservation. So far, a total of 2,724 plus trees have been selected from 28 species and about 781 ha of seed orchards are approved. Also, a total of 252.4 tons of seeds have been produced and supplied from the seed orchards. FRMs from seed orchard seeds are proven as superior to those from natural stands. The realized gain for volume growth ranged from 12 to 20% depending on site and species. Most conifer orchards are genetically thinned, and fully supply seeds for reforestation. Based on the genetic value and flowering assessment, we do genetic thinning and high genetic gain for volume growth is expected. Gene diversity of FRM is monitored by the concept of effective population size. Conserving and supplying of FRM is based on the scheme of OECD/CFRM.

Email: kangks84@snu.ac.kr

Sustainable development strategy of rosewood in Yunnan, China

Zhang Jinfeng, Geng Yunfen
Yunnan Academy of Forestry

“Rosewood” refers to a wide variety of richly hued, extremely durable and increasingly rare timbers harvested from an array of tree species worldwide, largely from the Dalbergia genus. Displaying a range of brown to reddish-black colours, rosewood timber is highly prized for decorative purposes and commonly used in luxury wood products.

According to the Chinese National Standards (2000), 33 tree species (from 5 genus and 3 families) are defined as rosewood mainly originating in the tropics and subtropics of Southeast-Asia, Africa, and America.

Rosewood resources are the basis of the rosewood industry development. Constantly increasing demand of the raw material was the guiding factor for the development of a flourishing rosewood culture in China which has been pushing forward the material demand over centuries. China has a more than 500 years’ exploitation history in rosewood since the early Ming Dynasty, and is the largest rosewood consumption country in the world, which made traditional used precious native rosewood tree species endangered and depends on import deeply.

For the sake of mitigating severely declining of rosewood resources, some SE-Asian rosewood growing countries have made great efforts on conservation of rosewood in recent years. At the 16th Conference of the Parties (COP), seven rosewood species were listed on CITES Appendix II and III. Moreover, nineteen species were listed on the red list of threatened species (IUCN-RED LIST).

To solve contradictions between conservation and exploitation, large demand and short supply and to fulfill in the long run; increasing rosewood plantation will be an essential solution. However, long investment period and lack of intensive plantation technology has become a key constraint for rosewood Development. The major supporting researches for rosewood sustainable development will include: 1) collection of germplasm resources and adaptability study on the of rosewood; 2) genetic improvement of rosewood trees in terms of fast growing, straight trunk, and high proportion of corewood; 3) intensive seedling raising techniques; 4) sustainable plantation patterns；5）intensive cultivation technology; 6) effective wood processing and utilization technology; 7) development and utilization of none timber part; 8) sustainability assessment.

Email: 1910323166@qq.com

Identification method study of the agarwood

Li Gaiyun
Research Institute of Wood Industry, Chinese Academy Forestry

Agarwood is one of the most precious forest products. It is generally paid attention to the spice market、pharmaceutical industry and collection culture. With the development of agarwood market, purity/authenticity and cultivated/wild agarwood identification is very important. Therefore, development of reliable agarwood analysis technology becomes the urgent needs to guarantee the healthy development of agarwood industry. This paper used alcohol soluble extract content, color reaction, thin layer chromatography (TLC) analysis methods, and the high performance liquid chromatography (HPLC), to identify cultivated、wild and falsify agarwood. The alcohol content is an important factor to measure the quality of agarwood, which is significantly higher than 10% regulated by Pharmacopoeia. The color reaction of cultivated agarwood shows pale cherry red or cherry red. But the wild ones show violet、light red and purple except cherry red. TLC is a simple and saving-samples method, and it shows clear fluorescent spots and good separation effect. By comparing with similarity evaluation, peak area of cultivated and wild agarwood, HPLC fingerprints and different common characteristic peaks are established. The difference of HPLC fingerprints can identify the agarwood effectively and accurately. This work will provide the reference for the establishment of quality evaluation system of agarwood.

Email: ligy@caf.ac.cn China

Moderate genetic diversity and genetic differentiation in the relict tree *Liquidambar formosana* hance revealed by genic simple sequence repeat markers

Sun Rongxi, Lin Furong, Huang Ping, Zheng Yongqi
State Key Laboratory of Tree Genetics and Breeding, Key Laboratory of Silviculture of the State Forestry Administration
Research Institute of Forestry, Chinese Academy of Forestry, Beijing, China

Chinese sweetgum (*Liquidambar formosana*) is a relatively fast-growing ecological pioneer species. It is widely used for multiple purposes. To assess the genetic diversity and genetic differentiation of the species, genic SSR markers were mined from transcriptome data for subsequent analysis of the genetic diversity and population structure of natural populations. A total of 10645 potential genic SSR loci were identified in 80482 unigenes. The average frequency was one SSR per 5.12 kb, and the dinucleotide unit was the most abundant motif. A total of 67 alleles were found, with a mean of 6.091 alleles per locus and a mean polymorphism information content of 0.390. Moreover, the species exhibited a relatively moderate level of genetic diversity (He = 0.399), with the highest was found in population XY (He = 0.469). At the regional level, the southwestern region displayed the highest genetic diversity (He = 0.435) and the largest number of private alleles (n=5), which indicated that the Southwestern region may be the diversity hot spot of *L. formosana*. The AMOVA results showed that variation within populations (94.02%) was significantly higher than among populations (5.98%), which was in agreement with the coefficient of genetic differentiation (Fst = 0.076). According to the UPGMA analysis and principal coordinate analysis and confirmed by the assignment test, 25 populations could be divided into three groups, and there were different degrees of introgression among populations. No correlation was found between genetic distance and geographic distance (P > 0.05). These results provided further evidence that geographic isolation was not the primary factor leading to the moderate genetic differentiation of *L. formosana*. As most of the genetic diversity of L. Formosana exists among individuals within a population, individual plant selection would be an effective way to use natural variation in genetic improvement programs. This would be helpful to not only protect the genetic resources but also attain effective management and exploit genetic resources.

Email: rongxisun@163.com

Regional networking for the conservation and management of forest genetic resources: priorities and experiences from around the world

Riina Jalonena, Michele Bozzanob, Marius Ekuéc, Evert Thomasd, Judy Loob

Populations of many ecologically and socio-economically important tree species are declining worldwide, according to the State of the World’s Forest Genetic Resources (FGR) Report that was based on country reports from more than 80 countries. In response, FAO launched a Global Plan of Action on Forest Genetic Resources to help safeguard these vital resources through in situ and ex situ conservation, sustainable management and strengthening of related policies and capacities. Here we present priorities and experiences of regional FGR networks which are assuming an important role in implementing the Global Plan of Action and have each developed their own strategies and priorities to that end. Networks on FGR were established in Asia and the Pacific (APFORGEN), Latin America (LAFORGEN), sub-Saharan Africa (SAFORGEN) and Europe (EUFORGEN) in 1990s and early 2000s, and together have members from more than 70 countries. Their current priorities include characterizing genetic resources and developing data systems to address the widespread lack of information on FGR, strengthening tree breeding and seed production systems to support forest restoration targets and increase socio-economic benefits from FGR, and mobilizing political and financial support for scaling up FGR conservation and management efforts. The networks could benefit from sharing technical expertise and experiences regarding what operational models help sustain and expand networks over time. Lack of core funding is a key challenge for the networks in the Global South. FAO has recognized the importance of regional networking in FGR conservation and management and called for support to networking efforts.

Email: r.jalonen@cgiar.org

Session C-07 (52): IUFRO task force on climate change and forest health

Developments in modelling forests and climate coupling

Alessandra De Marco[1], Alessandro Anav[1], Irene Cionni[1], Andrea Alessandri[1], Mihaela Mircea[1], Elena Paoletti[2]
1. ENEA
2. CNR

In the last decade the atmospheric pollution reached a worrying level in huge areas of North and South hemispheres and, as a consequence of the continuous increasing of anthropogenic emissions, it is expected that global pollution continue to rise in the next future. Considering the ecosystems and more closely terrestrial vegetation, among different atmospheric pollutants ozone is probably the most damaging to forest and crops frequently reaching high concentrations over large regions of the world. Recently it was found that over 90% of vegetation damage may be due to tropospheric ozone alone, and it could cause reductions in crop yield and forest production ranging from 0% to 30%. In fact, present concentrations are sufficiently high to negatively affect trees by decreasing foliar chlorophyll content and photosynthesis, leading to an alteration of carbon allocation in the different pools as well as visible foliar injury. The indirect CO_2 radiative forcing due to the vegetation damage effects of anthropogenic O_3 increases since the industrial revolution may be as large as +0.4 Wm^{-2}, which is 25% of the magnitude of the direct CO_2 radiative forcing over the same period, and of similar magnitude to the direct O_3 radiative forcing. As a consequence, is very important to quantify the impact of ozone on forests in present condition and future scenarios. Pre-industrial, present and future ozone concentrations have been analyzed at global level to assess their impacts on main important Plant Functional Type.

Email: alessandra.demarco@enea.it

An overview of the task force results and emerging issues for future developments

Elena Paoletti
SISEF

Global emissions of greenhouse gases have risen to unprecedented levels. Climate is changing by inducing an overall increased mean temperature and higher frequency of extreme events. Global forests are both affected by climate change effects and affect the climate system. Health of forests is instrumental in addressing their resilience to change and providing ecosystem services. To face this unprecedented challenge, IUFRO launched a Task Force on Climate Change and Forest Health, whose main aims are to improve our understanding of the processes regulating the interactions between forests and climate and to address how forest ecosystems can be made more resilient against climate. The multi-faceted aspects of these interactions pivot around forest health, with focus on nitrogen and ozone pollution, insect attacks, increased temperature and drought, and the carbon balance. The Task Force is divided into three pillars: Effects, Adaptation, and Mitigation. The aim of this presentation is to summarize the state-of-the-art of the Task Force activities and call for further contributions.

Email: elena.paoletti@cnr.it

Launching supersites for superior forest science - novelty, needs and networking

Rainer Matyssek
Technische Universität München

Anthropogenic pressure on forest ecosystems continues to increases worldwide through inherently linked effects of climate change and air pollution, both rooted in industrialization and land-use changes. Missing process-based understanding of such interrelationships is one major impediment in fathoming adaptation capacities of forests to anthropogenic stress and means of mitigation. Research unifying experimentation, monitoring and modelling on same forest sites is required for scenarios of air pollution as part of climate change for warranting reliable risk assessment and science-based management. Forest sites of such scope of integrated research have been termed “Supersites”, but are largely missing across hemispheres. Supersite research would need to be harmonized by an overarching research concept and coordinated within a global network structure.

The presentation will outline the novelty of Supersite research, exemplifying major, globally over-arching research needs, and suggest ways of networking and coordination. Research focal points are (i) interactions and effects of trace gases under climate change, (ii) biotic interactions in shaping ecosystem stress response, (iii) tool development fostering mechanistic and diagnostic understanding, (iv) integrative concepts for modelling and empirical assessments, and (v) global dimension of air pollution as intrinsic part of climate change. Arguments will be derived why existing research networks cannot meet requirements.

Email: matyssek@wzw.tum.de

Sustainable forest harvesting – climate change adaptation and mitigation practices

Enrico Marchi[1], Woodam Chung[2], Michal Brink[3], Andrew McEwan[4], Piotr Mederski[5], Tomas Nordfjell[6], Rien Visser[7]
1. University of Florence
2. Oregon State University
3. CMO (Pty) Ltd
4. Nelson Mandela Metropolitan University
5. Poznań University of Life Sciences
6. Swedish University of Agricultural Sciences
7. University of Canterbury

Intensified forest management is inevitable due to continuously increasing human population and their demand for wood products. It is important to recognize that forest harvesting intensity widely varies with different regions for a variety of reasons, and at the same time climate change directly and indirectly affect forest management activities, such as timber harvesting operations.

This presentation will provide the definition of sustainable forest harvesting, and discuss forest harvesting practices from climate change adaptation and mitigation perspectives. Sustainability should be based on both forest production and other ecosystem services. Environmental and social objectives also need to be met. As tools for sustainable forest harvesting, this presentation will introduce innovative harvesting systems and technologies, development of adaptive management and silvicultural regimes, and adaptive measures related to greenhouse gas emissions during harvesting. This presentation will also highlight some of the climate change causing challenges in harvesting operations and how adaptation and mitigation can be achieved by sustainable forest operations.

Email: enrico.marchi@unifi.it

Global ozone impacts on forest carbon and water use

Yasutomo Hoshika[1], Genki Katata[2], Makoto Watanabe[3], Makoto Deushi[4], Takayoshi Koike[5]
Elena Paoletti[1]
1. National Research Council of Italy
2. Japan Atomic Energy Agency
3. Tokyo University of Agriculture and Technology
4. Meteorological Research Institute
5. Hokkaido University

Tropospheric ozone concentrations have increased by 60–100% in the Northern Hemisphere since the 19th century. The phytotoxic nature of ozone can impair forest productivity. In addition, ozone affects stomatal functions, by both favoring stomatal closure and impairing stomatal control. Ozone-induced stomatal sluggishness, i.e., a delay in stomatal responses to fluctuating stimuli, has the potential to change the carbon and water balance of forests. In this presentation, our recent experimental results about stomatal sluggishness and the developments for the modeling study are summarized.

In the ozone FACE (Free-Air Controlled Exposure) experiments, we found that ozone caused: 1) slower dynamic stomatal response to light variation, 2) less sensitivity of stomata to vapour pressure deficit (VPD), 3) reduced sensitivity of stomata to abscisic acid (ABA) and 4) increased night-time stomatal conductance. As a result, ozone-induced stomatal sluggishness can be incorporated into modelling based on a simple parameter (gmin, minimum conductance) which is used in the coupled photosynthesis-stomatal model.

On the basis of the experimental results, we examined the effects of ozone-induced stomatal sluggishness on carbon gain and transpiration of temperate deciduous forests in the Northern Hemisphere by combining a detailed multi-layer land surface model and a global atmospheric chemistry model. At the original land surface model, ozone reduced water use efficiency (i.e., the ratio of net CO_2 assimilation to transpiration) up to only 5% since the stomatal sluggishness is neglected. However, when the process of stomatal sluggishness is included, the water use efficiency further decreased up to 20%. Our findings are consistent with previous experimental evidences, suggesting significant impairment of forest carbon and water balances attributed by ozone-induced stomatal sluggishness.

Email: hoshika0803@gmail.com

The significance of genetic structure of Scots pine stands surviving the effect of unfavourable environmental factors under the presses of climate changes

Ingrida Augustaitiene, Algirdas Augustaitis, Darius Danusevi?ius, Almantas Kliu?ius, Vitas Marozas, Gintautas Mozgeris, Edgaras Linkevi?ius, Marius Mikalajunas, Giedrius ?idlauskas
Aleksandras Stulginskis University, Kaunas Lithuania

In the presented study we attempted to detect variation in the genetic diversity and inbreeding of Scots pine population in Lithuania surviving attacks of needle eating forest pests under the presses of climate and air pollution changes. To genotype 150-200 sample trees with highly polymorphic nuclear SSR markers multiplexed with EST SSRs in each stand were chosen. 12 nuclear microsatellite loci were studied. DNA was extracted from wood using the ATMAB-method. Tree resistance to the unfavourable environmental factors was detected by applying long-term data set on tree crown defoliation and stem increment dendrochronology. The obtained data revealed that tree competition indices have more significant effect on tree condition and productivity than their genotype and inbreeding. These findings indicated that the harm of insect damage was quite similar for all trees independent of their genetic group. Only trees from genetic group with reduced genetic diversity demonstrated higher tree growth recovery rate and better crown condition (lover defoliation rate) than trees from genetic group with higher genetic diversity. In general, the environmental stresses reduced the genetic diversity of pine population when groups of genetically similar trees and most sensitive to the injury of forest pest are eliminated leaving less genotypic variants in the stands but more resistance to this stress after the injuries.

Email: iaugustaitiene@gmail.com

Session F-07 (101): Forest tenure reform process in developing countries: achievements and critical challenges

Forest tenure reform challenges: lessons from 40 years of community forestry programme in Nepal

Bijaya RajPaudyal
Ministry of Forest and Soil Conservation

Nepal has long been in the forefront of devolving forest management rights to local communities through community forestry and other similar community based modalities. Today, one-third of forests are under community forestry, involving almost 40% households. However, we have seen ups and downs during the four decades of community forestry programme with emerging challenges, particularly with the increasing interface with market, changing livelihoods strategies and competing use of forestlands. In this context, this paper brings historical evolution of community forestry in Nepal, its contextual factor and internal drivers; analyses the institutional landscape and maps out the current status of reform processes. It appears that the reform process has been slowed in the post 2000 era and additional challenges have emerged. The major challenge include: weak institutional capacity in the face of market interface, migration and changing rural demography, and growing stakes of distant actors in forest management. Consequently, while 40 years of community forestry has contributed much to regenerate forests in the once denuded Nepalese hills, its contribution to livelihoods and policy reduction is still inadequate.

Email: bijayapaudyal@hotmail.com

The knowledge sharing and information dissemination of China's collective forest tenure reform

Chen Shaozhi
Research Institute of Forestry Policy and Information, Chinese Academy of Forestry

The paper introduces the structure of forest tenure reform in China including forestlands and forest resources against the established concepts of community rights and tenure security. The paper makes a retrospective analysis of the context and drivers of emergence and evolution of China's Collective Forest Tenure Reform. The objectives, principles, activities and characteristics of China's Collective Forest Tenure Reform are explained together with the existing implementation mechanisms. By comparative analysis of before-and-after status of the forest tenure reform, the report summarizes the main outcomes and performance the Forest Tenure Reform. The paper then highlights the key insights from the successful experiences from China's Collective Forest Tenure Reform including the problems and challenges met during the process of the Reform implementation. The paper provides the empirical resources from the cases supporting the livelihoods of forest farmers and protecting women's rights over China's Collective Forest Tenure Reform. Finally, the paper offers some prospective outlook of the China's Collective Forest Tenure Reform.

Email: chensz99@vip.163.com

Securing tenure rights for forest dependent communities: The case of community forestry in Nepal

Naya SharmaPaudel
ForestAction Nepal

There is an increased interest in forest tenure reform globally, especially in the context of widespread poverty among forest dependent rural communities and resulting conflicts and resource degradation. Nepal has long been in the forefront of devolving forest management rights to local communities through community forestry. However, after four decades of tenure reform initiatives, there are still questions on the contribution of community forestry in supporting local livelihoods and contribution to poverty reduction. In this context, this paper examines the tenure in practice within the community forestry programme and its contribution to local livelihoods. It identifies key factors that shape the livelihoods outcomes of community forestry and analyses how management rights are being exercised to materialise the potential of forests in supporting local livelihoods and poverty reduction.

It appears that community forestry is moving slowly towards responding to the livelihoods and poverty agenda moving exclusive environmental concern of the past. There still needs some changes in regulatory and institutional framework, capacity building, mobilization of civil society organisations and supporting innovative community-private partnership to increase its contribution to poverty reduction.

Email: naya@forestaction.org

Outcomes of land and forest tenure reform implementation in Indonesia

Mani Ram Banjade, Tuti Herawati, Nining Liswanti & Esther Mwangi

Devolution of forest rights to local communities has received broad acceptance globally particularly in developing countries, which have undertaken land and forest tenure reforms. However there is a dearth of knowledge on whether and how these reforms have affected outcomes in terms of tenure security, livelihoods and forest condition. This paper analyses outcome of various forest tenure regimes in Indonesia based on the research from 16 forest communities, which fall under formal social forestry schemes, informal customary systems, and partnership schemes.

The results show that all the communities whose rights were legally recognized under the reforms had strong perceptions of tenure security. However, these communities also reported low increases in income, and limited efforts on ‘forest’ development after the reform is reported in most communities. Similarly, some communities have improved social, human and institutional capital, and have better access to market, and value addition of forest products. Reforms have failed to take into account gender differentiation and women’s voices in forest governance are generally ignored. Variation in outcomes within and across the formal reform types could be attributed to the disproportionate possession of extent, protection and assurance of rights, access to capital, capacity, biophysical conditions and post formation support.

Reform of forest tenure in Indonesia: challenges and opportunities

Wiratno
Ministry of Environment and Forestry, Indonesia

Indonesia has adopted social forestry program since the promulgation of Forest Act 41/1999 but major efforts were made since 2010 once the five-year (2010-2014) target of allocating 1.5m ha to local communities was set. The current mid-term national development plan (2015-2019) increased the target to 12.7m ha. The target is ambitious in the previous experience of slow implementation—only about one third of target could be met during 2010-2014. Identifying and addressing implementation challenges is key in achieving the ambitious target. The challenges include coordination among relevant line ministries and other CSOs and coordination across multiple scales, local capacity for managing the forest, capacity of agencies supporting forest reform implementation, and institutional capacity of community and other actors.

In recent years, however, positive initiatives are taken leading to effective forest tenure reforms in Indonesia. For example, CSOs, and bilateral and multilateral cooperation offer significant technical and financial support for reform implementation; district and province level leadership have provided strong and persistent support for social forestry program; the Ministry of Environment and Forestry has reviewed and deregulated relevant laws and regulations in favor of forest tenure reforms vis-à-vis integrate these reforms in line with larger rural development goals of poverty reduction.

Email: inung_w2000@yahoo.com

The trend & prospect of collective forest tenure reform in China

Miao Guangping
Department of Rural Forestry Reform & Development, State Forestry Administration

This paper briefly introduces the progress of Collective Forest Tenure Reform in China. The basic reform task of "clarifying ownership & issuing forest tenure cerificates" has been basically completed and main reform policy measures have been applied smoothly. The next step will continue to stabilize Collective Forest Land contracting relationship, to strengthen the protection of forest rights and interests, and to further give flexibilty in forest production & operation, to promote appropriate scale collective forest management, cultivate and expand the scale of main bodies in forest management as well as to enhance the collective forestry management efficiency.

Email: miao2000@foxmail.com

Session I-07 (107): Urban forests the foundation of sustainable future for human health and social well-being

Counseling utilizing urban forest: forest counseling

Iwao UEHARA
Tokyo University of Agriculture

Many attempts have approached to enhance and make clear the counseling effects. However, the attempts utilizing natural environment have been few. This study tried some case studies at urban forest and considered the special counseling effects. Each client regularly walked and stayed in the urban forest (forest park) with a counseling: We call it “Forest Counseling” (Uehara 1996). They watched forest scenery, lay on the forest floor, enjoyed seasonal changing with regular counseling. In addition, they did counseling indoor, too, to compare the difference and the effects. Common changes of the clients were change of air from ordinary environment and lives, getting ideas to solve problems, reconsidering oneself, easing problem condition by Forest Counseling for a few months. These results showed the effects and possibility of counseling utilizing forest environment. Especially, urban forest is easy to access and use by urban citizens. The numbers of people having mental and physical stress in the daily urban life has been increased. Therefore, urban forest has big potential for counseling and psychological green space for urban people. Also, forest showed three roles for the clients and a counselor by case studies: counseling peace place, indicator of clients’ psychological changes, and a being as a counselor.

Email: bigrock1964@hotmail.com

The effect of walking and attentive listening counseling utilizing urban forest parks

Hiroe TAKEUCHI[1], Satori NAGAI[2], Mariko KAWABATA[3], Iwao UEHARA[4]
1. Graduate School of Agriculture, Tokyo University of Agriculture
2. STEP Occupational Health Service Office
3. JUMOKU Ltd.
4. Tokyo University of Agriculture

This study firstly introduces the method of "walking and attentive listening counseling" in the forest environment. It is called Forest Walking Counseling, "FWC." Secondly, it evaluates the effectiveness of FWC through the several case studies utilizing urban forest parks. FWC is based on "Shinrin-Ryoho (Forest Therapy)" and aims that a client's feeling gets better after a forest counselor and the client are walking together. There are four additional elements. Firstly, the forest counselor listens to the client attentively and empathetically with walking in the natural environment. Secondly, if the client does not wish to speak about anything while walking in the forest, the forest counselor accepts the client's condition and they spend time by walking in silence. Thirdly, the forest counselor does not advice the client, but the forest counselor aims to get the client to become aware of one's mental affliction by oneself. The forest counselor introduces the client trees, their forms, leaves, woody plant physiology, and other nature related topics when the forest counselor believes it is appropriate. Lastly, the forest counselor always needs to observe the client and perceive her condition.

Email: t_hiroe@hotmail.com

N changes in post-transplant Buddhist pine and Northeast yew seedlings with contrasting initial sizes induced by photoperiods in response to simulated urban and rural environments

Wei Hongxu[1], He Xingyuan[1], Zhang Qichang[2], Ge Lili[2]
1. Northeast Institute of Geography and Agricultural Ecology, Chinese Academy of Sciences, Changchun 130102, China
2. College of Forestry, Beihua University, Jilin 130000, China

Large-scale tree planting projects in cities are increasingly implemented as a strategy to improve the urban environment. High-value ornamental tree stocks usually need a long term of culture before transplant, which are widely suggested to be countered by promoting their growing rate under an extended daily photoperiod. However, evidence about the post-transplant performance of photoperiod induced seedlings in urban environment is still scarce. In the present study, two highly valued and slowly growing ornamental tree seedlings of Buddhist pine (*Podocarpus macrophyllus*) (PM) and Northeast yew (*Taxus cuspidata*) (TC), were obtained from sub-tropical temperate and temperate latitudinal populations, respectively, and cultured under contrasting photoperiods for one year in 2014 to result in different sizes. On 16 April 2015, seedlings were transplanted to simulated urban and rural environments and harvested at 27 October 2015. During this period, shoot nitrogen (N) concentration declined to be negative and more declines occurred in urban-growing seedlings than in rural-growing ones for both species (PM, PP=0.0046). Accordingly, shoot N content declined by 67% (PPP=0.0012), which, however, did not cause the response of TC-root N content. Larger-size seedlings generally had less N concentration decline in shoot (PM and TC, PP=0.0034; TC, PP=0.0003 and P=0.0015, respectively). In conclusion, urban environment stimulated more shoot N depletion in post-transplant seedlings than rural one, but photoperiod-induced larger-size seedlings can maintain N content by promoting biomass accumulation. These responses were species-specific according to the ability of biomass accumulation.

Email: weihongxu@iga.ac.cn

Scenic beauty in the streetscapes: assessment of commuting corridors in Vancouver

MikiNarukage, MichaelMeitner, StephenSheppard, PatrickMooney
The University of British Columbia

As increasing number of patients with mental disorders, the benefits of green infrastructures on stress reduction have drawn attention. While it has been well studied the aesthetic quality of urban parks, limited studies on that of streetscapes have been done. The objective of this study is to seek out the biophysical components that can significantly enhance the scenic beauty of urban streets in Vancouver, BC.

The stimuli were sixty images showing the driving perspective. (1) The number of pixels occupied by the tested 24 environment variables for each image was counted. (2) 47 university students took part in a perceptual survey where they judged the perceived scenic beauty of sample images on a 10-point scale. (3) The correlation between the pixel counts for the variables and the Scenic Beauty Estimates points calculated from the ratings was examined.

As a result of stepwise regression analysis, the area of trees, green grass, hedges, the symmetrical arrangement of trees aligned with the sides of streets, and the view of the mountains could increase the estimates of beauty substantially, in this order. These findings proposed the optimal choices of vegetation types and spatial allocation of trees for better design of urban streets, and they could also contribute to create healthy landscape for urban dwellers.

Email: miki.narukage@alumni.ubc.ca

Urban-rural gradients and long-term records highlight increases of woody species and bird biodiversity in Harbin city, northeastern China

Wang Wenjie[1,2], Xiao Lu[2], He Xingyuan[1], Lv Hailiang[1], Wei Chenghui[2], Zhou Wei[2], Zhang Bo[2]
1. Urban forest and wetland research group, Northeast Institute of geography and Agroecology, Chinese Academy of Science, Changchun 130102, P.R. China
2. Key Laboratory of Forest Plant Ecology, Northeast Forestry University, Harbin 150040, P.R. China

Both landscape gradient and temporal data confirmed that urbanization had the function of species conservations with sharp increases of alien species and tropical type plants. In the case woody species, 60-yr urbanization in Harbin had induced increases of 9 families and 17 genera, and there were 7-20 more families, 12-35 more genera, 1.6-2.6 higher Margalef richness in urban areas than those in nature reserves and local forest farms; Increases in alien species (4-fold in 60-yr urbanization; 21% in urban area vs 1.6 in non-urban area) were mainly responsible for these compositional changes, which can be proved by their significant correlations. Moreover, moderate disturbance had peak values in alien species, tropical type plants, Shannon-wiener diversity, Margalef richness index and Pielou evenness index, and both ringroad- and buildup history gradients showed the similar tendency. Compared with those in 1980s, forest- and eurytopic-habitats birds increased 9-11 species (23-39%), and omnivorous, insect-eating, and phytophagous bird increased 5-9 species (14.1-29.4%) in those in 2010s, indicating that bird temporal changes were closely related with the changes in urban forests owing to food supply and habitat provision. Our findings could provide data for biodiversity evaluation of urbanization effects, and is also useful for ecological re-construction of local cities in China.

Email: wangwenjie@iga.ac.cn

Urban forest research in China:progress and prospects

He Xingyuan
Northeast Institute of Geography and Agroecosystem, Chinese Academy of Sciences

It is widely recognized that urban greening can make a significant contribution to reduce these detrimental effects of urbanization and improve liveability. Although urban greening in China originated a long time ago (over thousands of years), the countrywide development of urban forestry was launched since 1949, and reinforced after 1978. Accompanied with the rapid urban sprawl in the last two decades, forests in China's urban areas were dramatically increased under the government's "urban greening" policy. More and more new parks, community gardens, trees in open space, and street trees were generated and used for recreation by the public. It was reported that the green-space cover within the urbanized areas averages 35.8% in 2014. From that period (1990s), Municipal Bureau of Landscape and Forestry from Chinese cities have produced good conceptual frameworks, principles, guidelines and practical methods for urban greening programs. More importantly, Chinese research scholars recently have devoted significant progress in urban forestry. Most studies focused on urban forest cover and spatial distribution, species composition and selection, ecosystem services and values, climate change effects, trees management and policy. However, further work is required to promote the design of urban forest associated with human recreation, extend urban forest education and develop sustainable management of urban forest.

Email: hexingyuan@iga.ac.cn

Session A-08 (78): Linking life-cycle assessment to sustainable forest and forest product carbon management activities

Comparison of three international standards of product carbon footprint

Wang Zhen, Li Nan, Liu Yi
Beijing Forestry University

Product carbon footprint (PCF) is becoming a new strategy and criteria for companies to evaluate their environmental performance along supply chain, which may affect the global carbon emission reduction fundamentally. As a matter of fact, however, there are different kinds of standards to calculate PCF even for the same types of products. Theoretically, the accurateness of the value of the carbon footprints relies on what kinds of standard are the calculation adopted. Currently there are three major international standards to account PCF, including ISO/DIS 14067(draft international standard), PAS 2050(2011 version), and GHG protocol (Product Life Cycle Accounting and Reporting Standard). Unfortunately, there are many differences among these three international standards. When individual country or company selectively refers to one or two or all three of these standards, the ignorance of these differences may make the comparison of PCF between different parts difficult and incredible. In this research, the differences among these three PCF international standards were clarified and analyzed, with ISO14044 referenced as the fundamental life-cycle-analysis framework.

The results show that, despite three Standards are consistent each other generally, they all have their own advantages respectively. The ISO Standard specifies in "interpretation" part of life-cycle-analysis and has an explicit structure in accordance with ISO14044. As to GHG protocol

Standard specifies in three aspects of life-cycle-analysis, including "data collection, allocation rules and uncertainty analysis". With respect to PAS 2050 Standard, "scope and boundary" definitions are specified into certain sub-processes; in addition, it provides specific parameters which lay a solid baseline for product comparison. Individual standard could not stand alone to provide a comprehensive and specific instructions, however, due to each one has weak points that may be the comparative advantages of others. Moreover, we also find that there are some contradictions on some important steps of life-cycle-analysis, which could lead to significant differences of the accounting results ultimately. Such as, how to treat specific emissions and removals like "aircraft and carbon storage" in the inventory analysis step, how to choose "facility lighting, air conditioning and prototyping" in the system boundary definition step, and how to use "closed loop approximation method" in the allocation step. These contradictions are probably be conductive to the carbon labelling certification system associated with international supply chain. Based on the above findings, we suggest that the ISO14067 should be developed to align this differences in international standards. Considering individual country refers to merge different standards into its own one, international standards should play supplementary roles to each other from a point view of life-cycle-analysis method. Overall, a more consistent, transparent and practical system formed by international standards is required to serve for reducing carbon emission effectively.

As to case study, we use one set of wooden cabinet product, manufactured by a local Chinese company, to recognize the differences when practicing three standards. The result shows that, PCF counted from ISO14067 is the biggest one in three standards, which is 1.29 & 1.29 times than PCF from PAS2050 & GHG protocol under the cradle-to-gate scenario, and 1.26 & 1.27 times under the cradle-to-grave scenario.

Email: wangzhen@bjfu.edu.cn

Carbon management for the entire chain of forest biomass production and utilization – Finnish experience

AshrafulAlam
University of Eastern Finland

Abstract:Assessing climate benefit of forest biomass production and utilization require holistic understanding of the carbon flows between ecosystem, technosystem and atmosphere continuum. Here, we analyzed carbon dynamics in different pools of forest ecosystem under alternative forest management regimes (business as usual, intensive, less intensive and unmanaged forest). Furthermore, carbon flows in technosystem was considered by employing various life span of harvested forest products' (sawn and pulp). The analysis was done by utilizing combined ecosystem model and a life cycle assessment tool for a Norway spruce stand grown in Finnish condition. The results indicated that managed forests may contribute to climate mitigation at higher level compared to unmanaged regime. Ecosystem carbon dynamics affected by forest management has a crucial role for carbon sequestration in forest and beyond forest ecosystem (i.e., technosystem). Carbon residence time can be extended in ecosystem by focusing forest management and also in technosystem by utilizing forest biomass with to without changing the products' life span. The study suggests that carbon management in ecosystem and technosystem can be an effective tool to improve climate mitigation potential of forestry sector.

Email: ashraful.alam@uef.fi

Life cycle assessment of thermally modified timber treated in atmospheric steam: a cradle-to-gate study

Ding Tao, Zhou Jun, Zhou Handong
Nanjing Forestry University

Wood thermal modification can significantly improve the dimensional stability and biological durability of wood by treating them at 160~220°C in inert atmosphere, and is believed to be one of the most promising wood modification methods. Thermally modified timber (TMT) is widely considered eco-friendly because no chemical substances are applied during the treatment. However, quantitative information on environmental performance of TMT is still limited. In this study, a life cycle assessment (LCA) was carried out on TMT treated in atmospheric steam. The data of the raw material gathering and manufacturing stages of the product were analyzed by using Simapro, a LCA software. Sensitivity analyses were made on some hypotheses of the study and suggestions were given on the environmental performance improvement. The results show that the main environmental advantage of TMT lies in its impact on climate change. Species and timber thickness are the main factors influencing the environmental performance of TMT.

Email: dtroy921@hotmail.com

Climate change mitigation through biomass to bioenergy conversion using forest residues from sustainable forest activities

Hongmei Gu[1],Richard Bergman[2],Nathaniel Anderson[2]
1. USDA Forest Service, Forest Products Laboratory
2. U.S. Forest Service Rocky Mountain Research Station

Forest residues as a byproduct of timber harvests and forest restoration treatments in the United States is a promising feedstock for the production of biofuel and bioproducts. Such conversion and production of energy has a great impact on global warming reduction and climate change mitigation. We have demonstrated the potentials for integrating sustainable biofuels and bioproducts production into forest industry supply chains using a modular biomass to bioenergy conversion system and carbon activation technology. Conforming to the internationally accepted life cycle assessment (LCA) method, this study developed the cradle-to-grave LCA according to the ‘Tool for the Reduction and Assessment of Chemical and other environmental Impacts’ (TRACI) method impact categories for syngas electricity and biochar activated carbon. These were the two main products derived from the thermochemical conversion process. Syngas electricity as the bioenergy product was compared to the commercial electricity technologies. In addition, activated carbon (AC) from the biochar generated was compared to the market available coal AC on their environmental impacts. Both LCA results confirmed the reduction in the GHG emission and fossil energy consumption. This approved the effective mitigation of climate change with the integration of sustainable forest management into the social energy and consumer products change from fossil-based to the biomass-based development.

Email: hongmeigu@fs.fed.us

Life cycle assessment and carbon-mitigation potential of timber products made of oil palm wood

Arno Fruehwald[1],Fabian Meinker[1],Jegatheswaran Ratnasingam[2],Nikhom Laemsak[3],Erwinsyah[4]
1. Center for Wood Science, University of Hamburg
2. Faculty of Forestry, University Putra Malaysia
3. Faculty of Forestry, Kasetsart University, Thailand
4. Indonesian Oil Palm Research Institute

More than 100 million m^3 of Oil Palm Trunks (OPT) are cut down each year. Presently, there is no use because of material properties, difficult drying and machining. An international project (PalmwoodNet) deals with all relevant aspects to commercialize OPT for products and energy, including environmental aspects. A sub-project deals with LCA and carbon aspects, the results are presented in this paper.

The material balance from trunks to finished products like dimensioned sawn timber, glued solid wood products like glue-lam and CLT, block-boards and door core elements, furniture components shows an average material recovery of 30% compared to trunk volume with remaining processing residues 35% wet, 27% dry and 8% shrinkage. Although processing thermal energy is 20% higher, the LCA results are similar to products manufactured from conventional wood species.

In the study the carbon mitigation potential is subdivided into products carbon sink, substitution effects from material use and energy use. The effects from plantation are studied using different approaches.

Assuming the use of 50 million m^3 trunks per year for manufacturing the above mentioned products, the carbon mitigation potential for Thailand is 1 million tC per year (1.2% of the present annual emission), for Malaysia 6 million tC (10%) and Indonesia 12 million tC (11%). The results show a high potential for climate mitigation at low “environmental costs”.

Email: arno.fruehwald@gmx.de

Session B-08 (54): Status of regeneration, management and conservation of Asian oak forests

Diversity and distribution of oak species and spatial pattern of oak forests in Northeast India

SarojKanta Barik, Prem Prakash Singh, Dibyendu Adhikari
North-Eastern Hill University

Understanding the diversity and distribution of oak species, their environmental correlates and spatial pattern of oak forests are essential pre-requisites for developing silvicultural systems, and designing conservation and restoration strategies for management of oak forests. Of the three botanical regions of India where oaks are found, except western Himalayas, no comprehensive distributional data for oak forests and diversity of oak species is available for eastern Himalaya and northeast India botanical regions. In the present study 16 species have been reported from these two botanical regions based on primary survey, and the spatial pattern of distribution of oak

forests have been assessed through extensive field visits and using imageries and GIS tools. The potential distribution areas of these oak species have been mapped using ecological niche modeling. The environmental correlates of oak species and forest distribution in the region viz., climate, topography, and soil characteristics were identified using multivariate models. Besides the diversity and distribution mapping of oak forests for the eastern Himalaya and northeast India, the study shows that the oak species of the region occupy varied environmental niches. The data on differential niche preferences among the species should be useful for habitat/species conservation, and development of appropriate silviculture systems for the degraded oak forests of the region.

Email: sarojkbarik@gmail.com

Disturbance driven vegetation dynamics: regeneration and survival of late successional oak species in the Central Himalayan forests of Uttarakhand

Niyati Naudiyal[1], Joachim Schmerbeck[2]
1. TERI University, New Delhi, India
2. Institute of Forest Sciences, Faculty of Environment and Natural Resources, University of Freiburg, Germany

We studied the successional dynamics in mid-montane Central Himalayan forests of India, focusing on the anthropogenic drivers affecting Oak regeneration and development. Succession was studied through an unreal time series of five vegetation types (Grasslands, Pine, Pine-Oak, Open Oak, and Dense Oak) representing a theoretical successional sequence from early to late successional stages. These sequential vegetation types were assessed by means of a systematic vegetation survey analysing species composition, structure and regeneration, under similar site conditions.

Our results highlight chronic fires and grazing as primary factors restricting establishment of Oaks in the study area. Early successional Grasslands and Pine forests harbour high densities of Pine and Oak seedlings respectively. However, chronic annual fires accompanied by unsustainable levels of grazing in early successional stages obstruct progressive succession towards a broadleaved Oak community by eliminating regenerating seedling and saplings from the forest understory. In intermediate and late successional stages (Pine-Oak, Open Oak, and Dense Oak) overexploitation of existing Oaks via lopping and grazing act as counterproductive feedback mechanisms hampering Oak regeneration and development.

We conclude that the extent of Oak forest in the study area can be increased with management plans that restrict anthropogenic disturbances while utilising the ability of Pine to foster Oak regeneration and conserving existing Oak forests.

Email: niyati.n22@gmail.com

How to manage oak forests towards multi-functional forest based on the integration of structural elements? ——a case study in the Loess Plateau in Northwest China

Guan Shunyun[1], Liu Xianzhao[2], Lu Yuanchang[2], Sven Wagner[1]
1. Technische Universität Dresden (TUD), Faculty of Environmental Science, Department of Forestry
2. Research Institute of Forest Resource Information Techniques, Chinese Academy of Forestry

Oak, one of the main tree species with multiple uses and values in China, plays a crucial role especially in an ecologically vulnerable area like the Loess Plateau in Northwest China. Increasing attention has been paid to developing multi-functional forestry in China, however, the awareness of multi-functional management of oak forests as well as its related studies are still lacking. The traditional way of forest management by segregating conservation-oriented and production-oriented forests at landscape level with single specialized uses may not be able to adapt to the diverse demand for oak forest resources by different sectors in China. In order to meet this challenge, the multi- functional management of oak forests based on the integration of multiple services at stand level is suggested, by means of combining different forest structural elements that support specific ecosystem services. Therefore, this study is mainly focused on the main stand types of oak forests in Shaanxi Province, where about 70% of forest area is dominated by oak, including oak high forest (both natural and planted, pure and mixed) and oak low forest, etc. It aims to study how to achieve the management goal of combining both ecological services (biodiversity and soil water conservation) and economic service (timber production) within a management unit through close-to-nature silviculture practices. According to the assessment and evaluation of stand structure and the determined services of each type of oak forest and the analysis of the compatibility between different forest services based on the related structural elements, suggestions on the multi-functional forest management measures and management objectives based on the optimization of stand structure will be proposed, providing scientific theory base for sustainable forest management of oak forests in China.

Email: guanshunyunavic@163.com

Final results of oak cluster planting experiments and scope for oak forest restoration in Asia

Somidh Saha
Albert Ludwigs University of Freiburg

Oak clusters are uniformly distributed ‘nests’ (nest planting) or ‘groups’ (group planting) that consist of 20 - 30 seedlings planted in an aggregated manner with 0.2 or 1m^2 initial spacing and approximately 200 or 100 such clusters ha^{-1}, respectively. I examined how tree growth, quality, tree species diversity and stand productivity differed between uniformly planted clusters and high-density row planting. The response of intra and interspecific competition on oak growth and quality was quantified. A meta-analysis (25 cluster and row planting trials) was carried out on inventory data to compare oak growth, quality and survival between cluster and row planting in Germany, Austria and Switzerland. Tree species diversity, stand productivity and tree competition were calculated in 7 trials in Germany. I found that tree survival, growth, tree stability, branch free bole length, and proprtion potential future crop tree did not differ significantly between group and row planting. The oak trees growing in groups had less chance to grow epicormic shoots. However, responses of these variables in nest planting were inferior to row planting. Natural regeneration in group planting was significantly higher than row planting; however, stand productivity did not differ between group and row planting. Oak group planting had higher tree

species diversity than row planting. Mid and late successional trees had a higher negative effect on oak growth in clusters than pioneer trees which are often regarded as stronger competitors. I recommend foresters to pursue group planting when objectives are to reduce initial planting cost, increasing tree species diversity without compromising desired silvicultural quality of target trees. In addition to presenting past results, the scope of oak cluster planting in Asian perspective will be presented.

Email: somidh.saha@waldbau.uni-freiburg.de

Effects of nitrogen supply and container size on seedling quality of *Quercus variabilis* in poor fertility and vegetation competing sites

Cheng Zhongqian[1], *Li Guolei*[2]
1. Research Institute of Forestry Policy and Information, Chinese Academy of Forestry
2. Key Laboratory for Silviculture and Conservation, Ministry of Education, Beijing Forestry University

Nitrogen (N) supply and container size are viewed as two common measures for producing seedlings at nursery to adapt to out planting sites especially harsh conditions. Their interactive effects on seedling growth, nutrient status and field performance in poor fertility and vegetation competing sites remain unknown. *Quercus variabilis*, one of the most widespread tree species in North China, planted in containers with depths of 25 and 36 cm were received a total of 25 and 100 mg N, respectively. Seedlings were transplanted in pots filled with sand as well as out planted in two distinct weed condition sites in the following year. High N supply improved current stem biomass and N content in poor fertility soil, and RCD in weed competition trail. Deep container increased biomass, P and K content in poor fertility soil as well as height and RCD in weed competition trail. Interactive effects affected height, RCD and root N content in poor fertility soil and root P content in weed competition trail significantly. We conclude that sufficient N supply and deep container could be used to produce specific oak seedlings to decrease the use of herbicide, increase seedling vigor, save the labor and meet particular site requirements.

Email: winnie_czq@hotmail.com

Niches and interspecific associations of dominant tree populations in three succession stages of natural secondary forest on Loess Plateau, P.R. China

Li Gu
Northwest A&F University

Studying the niches and interspecific associations of plant species may provide valuable insights into processes and mechanisms that maintain species coexistence hence have important implications for optimal forest management and restoration in degraded forest ecosystems. *Quercus wutaishansea* forest is one of the major forest types on Loess Plateau, nouthwestern China, which is generally considered to be the climax vegetation in the region, however, little is known about the niches and interspecific association of dominant species. So the main goal is to explore interspecific association and dynamic changes of arbors. Niche breadth, overlap and chi-square text statistics were used to characterize the niches and interspecific associations of dominant species in three 1-ha permanent forest plot on Loess Plateau. All trees in the entire plot showed a reverse J-shaped distribution in both plots, the subclimax community with *Pinus*

tabulaeformi as the majority had developed into the climax community with *Quercus wutaishansea* as the majority. With changes of the dominant species, importance values and the value for niche breadth and overlap were changing. Overall interspecies association of the three community exhibited positive association for VR>1; the value of χ2 significance test further revealed that the overall association had reached the level of significant association. Among the total 45 species pairs composed of 10 dominant species, in the *Pinus tabulaeformi* forest (community I), the ratio of positive and negative associations of species was below 1, which 19 pairs showed positive association, 25 pairs showed negative association, and 1 pair showed no association; Contrast, In the *Pinus-Quercus* forest (community II) and *Quercus wutaishansea* forest (community III), the ratios of positive and negative associations of species were above 1, positive association pairs was accounting for 55.56%, negative association was only accounting for 44.44%. The timing and the consequences of these associations may illuminate how interaction mechanisms such as competition and alleopathy structure successions, then the differences of species features in niches and associations should be paid more attention when planning forest management and developing restoration strategies.

Email: guli_bj@126.com

Session C-08 (91): Microbial biodiversity in Asian forests: opportunities or threats?

Fungal community structure and function shift across a boreal forest fire chronosequence

SunHui[1,2],MinnaSantalahti[1],JukkaPumppanen[3],KajarKoster[1],FrankBerninger[1],TommasoRaffaello [1],AriJumpponen[4],Fred Asiegbu[1],JussiHeinonsalo[1]

1. University of Helsinki,Helsinki, Finland

2. Nanjing Forestry University, Nanjing, China

3. University of Eastern Finland, Kuopio, Finland

4. Kansas State University, Manhattan, Kansas, USA

Forest fires are a common natural disturbance in forested ecosystems and have a large impact on the microbial communities in forest soils. The response of soil fungal communities to forest fire is poorly documented. Here, we investigated fungal community structure and function across a 152-year boreal forest fire chronosequence using high-throughput sequencing of the internal transcribed spacer 2 (ITS2) region and a functional gene array (GeoChip). Our results demonstrate that the boreal forest soil fungal community was most diverse soon after a fire disturbance and declined over time. The differences in the fungal communities were explained by changes in the abundance of basidiomycetes and ascomycetes. Ectomycorrhizal (ECM) fungi contributed to the increase in basidiomycete abundance over time, with the operational taxonomic units (OTUs) representing the genera *Cortinarius* and *Piloderma* dominating in abundance. Hierarchical cluster analysis by using gene signal intensity revealed that the sites with different fire histories formed separate clusters, suggesting differences in the potential to maintain essential biogeochemical soil processes. The site with the greatest biological diversity had also the most diverse genes. The genes involved in organic matter degradation in the mature forest, in which ECM fungi were the most abundant, were as common in the youngest site, in which saprotrophic fungi had a relatively higher abundance. This study provides insight into the impact of fire disturbance on soil fungal community dynamics.

Email: hui.sun@helsinki.fi

Reassessment of the genus *Botryosphaeria*, including new additions and novel species from China

Zhou Yupei[1], He Wei[2],DraginjaPavlic-Zupanc[3],JolandaRoux[4], Zhang Ying[1]
1. Institute of Microbiology, PO Box 61, Beijing Forestry University, Beijing 100083, PR China
2. Beijing Key Laboratory for Forest Pest Control, Beijing Forestry University, Beijing 100083, PR China
3. Department of Microbiology, Forestry and Agricultural Biotechnology Institute(FABI), DST-NRF Centre of Excellence in Tree HealthBiotechnology, Faculty of Natural and Agricultural Sciences, University of Pretoria, Pretoria, 0028, South Africa
4. Department of Plant and Soil Sciences, Forestry and Agricultural Biotechnology Institute(FABI), Faculty of Natural and Agricultural Sciences, University of Pretoria, Pretoria, 0028,South Africa

The genus *Botryosphaeria s.s*. is represented by *B. dothidea*, and only eight species have been confirmed within this genus so far. In order to confirm the generic status of other species within *Botryosphaeria s.l*. Type specimens of *B. aterrima, B. hamamelidis, B. mirabile* and *Melanops cruenta* were redescribed and illustrated. Specimens of *Botryosphaeria*, including those of *B. laricina*, a causal agent of shoot blight and twig dieback of larch, were collected from several locations in China. DNA was extracted from the type specimens and isolates, and four nuclear loci, ITS, LSU, EF1-α,β-tubulin were sequenced. Based on the multigene phylogeny, *B. hamamelidis, B. laricina* and *M. cruenta* were transferred to *Neofusicoccum* as *N. hamamelidis, N. laricina and N. cruenta respectively*. The generic status of *B. aterrima* and *B. mirabile* within *Botryosphaeria* are confirmed. One new species of *Botryosphaeria, B. rosaceae* was described in this study. The genus *Botryosphaeria* now includes *B. agaves, B. aterrima, B. cortices, B. dothidea, B. fabicerciana, B. fusispora, B.mirabile, B. ramosa, B. scharifii, B. sinensia* and *B. rosaceae.* Of which *B. fabicerciana, B. sinensia* and B. rosaceae have been reported from China.

Email: yinghku@gmail.com

Diversity and distribution of *Botryosphaeriaceae* from native *Melastomataceae* (*Myrtales*) species in Southern China

DraginjaPavlic-Zupanc[1], Zhang Ying[3], Chen ShuaiFei[4,1], He Wei[5], JolandaRoux[1,2]
1. Forestry and Agricultural Biotechnology Institute (FABI), Faculty of Natural and Agricultural Sciences, University of Pretoria, Private Bag X20, Pretoria, 0028, South Africa
2. Department of Plant and Soil Sciences, Faculty of Natural and Agricultural Sciences, University of Pretoria, Private Bag X20, Pretoria, 0028, South Africa
3. Institute of Microbiology, Beijing Forestry University, P.O. Box 61, Beijing 100083, China
4. China Eucalypt Research Centre (CERC), Chinese Academy of Forestry (CAF), ZhanJiang 524022, GuangDong, China
5. College of Forestry, Beijing Forestry University, Beijing 100083, China

The *Botryosphaeriaceae* are common endophytes and latent pathogens of a variety of native and introduced woody plants worldwide. Various studies are ongoing to better understand the host, climatic and geographic ranges of these fungi, in order to better assess their current and future threats to plant health. A collaborative project between China and South Africa has been established to characterise *Botryosphaeriaceae* on *Myrtales* species. *Botryosphaeriaceae*

species were collected from two evergreen shrubs, *Melastoma sanguineum* (Blood-red *melastoma*) and *M. candidum* (Asian melastoma) that are native in southern China. Isolates were identified based on phylogenetic analyses of ITS rDNA, β-tubulin and RPB2 sequences. Five phylogenetically distinct groups within *Lasiodiplodia* were recognized for isolates from HaiNan Province. One of them represents an unknown species, and four were identified as *L. gonubiensis, L. lignicola, L. pseudotheobromae* and *L. theobromae.* The latter two and *Botryosphaeria ramosa, Neofusicoccum mangiferae* and an unknown *Lasiodiplodia* species were identified from *Melastoma* species sampled in GuangDong Province. The species composition differs significantly between the two locations, however, most of the species overlap on the two hosts where they co-occurred in the same location. The native *Melastoma* shrubs in the GuangDong Province grow in close proximity to Eucalyptus plantations known to harbour some of these *Botryosphaeriaceae,* and are exposed to anthropogenic disturbance, contrasting undisturbed sites in the native forest in HaiNan Province, which can contribute to the higher observed diversity of *Botryosphaeriaceae* on these trees in Guangdong.

Email: pavlicdr@gmail.com

A new genus of Cryphonectriaceae causes stem canker on *Lagerstroemia speciosa* (*Lythraceae, Myrtales*) in south China and could threaten eucalyptus propagation

Chen ShuaiFei[1,2], Liu QianLi[1], Li GuoQing[1],JolandaRoux[3], Michael J.Wingfield[2]
1. China Eucalypt Research Centre (CERC), Chinese Academy of Forestry (CAF), ZhanJiang 524022, GuangDong Province, China
2. Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Pretoria 0028, South Africa
3. Department of Plant and Soil Sciences, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Pretoria, 0028, South Africa

Eucalyptus and other trees residing in Myrtales have been widely planted in South China but relatively little is known regarding the fungal pathogens that affect them. These pathogens include members of the Cryphonectriaceae that are well-known to cause stem canker diseases on members of the Myrtales. Previous research has shown that some species of Cryphonectriaceae have undergone host jumps from native Myrtales to infect Eucalyptus. Recent disease surveys in the HaiNan and GuangDong Provinces of South Africa have revealed a previously unknown stem canker disease on *Lagerstroemia speciosa* (*Lythraceae, Myrtales*) trees. Fruiting structures with typical characteristics of the Cryphonectriaceae were observed on the surfaces of cankers. In this study, the fungus was identified and its pathogenicity to *L. speciosa* was tested. Multigene phylogenetic analyses were conducted based on DNA sequence comparisons of the partial LSU gene, ITS region of the nuclear ribosomal DNA gene and two regions of the β-tubulin (BT) gene. The results showed that the fungus represents a previously undescribed genus and species in the Cryphonectriaceae. Inoculations showed that this fungus is pathogenic on *L. speciosa* branches. Future studies will determine whether this newly discovered pathogen is able to infect Eucalyptus trees and aim to understand its potential threat to Eucalyptus propagation.

Email: shuaifei.chen@gmail.com

Arbuscular mycorrhizal dynamics in a chronosequence of betula alnoides plantations in tropical Yunnan and main soil properties involved

Jing Yuebo[1], Li Rongbo[1], Qiu Qiong[1], Zhao Zhiwei[2]
1. Yunnan Academy of Forestry
2. Key Laboratory of Conservation and Utilization for Bioresources, Yunnan University

As a multipurpose indigenous species, *Betula alnoides* was widely planted as a promising tree species to produce timber and regenerate degraded areas in tropical and south sub-tropical mountainous regions of Yunnan province. Arbuscular mycorrhizal fungi (AMF) are a globally widespread obligate symbionts of plant roots, where they establish an intimate relationship called mycorrhizal symbiosis. This association is strongly implicated in plant nutrient acquisition from soil, tolerance to biotic and abiotic stresses, and interaction with other organisms including interplant competition, AMF is well represent the dominant mycorrhizal form in tropical forests, and the diversity of AMF is an important aspect characterized the stability of the forest system. In this study, choosing five B. alnoides plantations in Xishuangbanna Puwen experimental forest farm of Yunnan province in southwest China, that had been established for 2, 8, 11, 19 and 21 years, two B. alnoides plantations in Ruili of Dehong prefecture of Yunnan province that had been established for 3 and 5 years, and the natural forests in two study areas adjacent to the plantations as sample plots, the AMF colonization in roots of B. alnoides and AMF spores in the rhizosphere soil were studied, the soil properties were analyzed; with the objectives of exploring the AMF status and composition in a chronosequence of B. alnoides plantations, and the effects of soil properties on AMF. The results showed that the colonization percentage of AMF hypha, arbuscule and vesicle in root system of B. alnoides trees varied from 17.35 % ~ 68.79 %, 0 ~ 8.76 %, 1.99 % ~ 26.88 %, and the AMF spore density in rhizosphere soil ranged from 1117 ~ 12507 spore/100 gdry soil. It was found that within the roots of B. alnoides, no regular changes of AMF colonization in response to the succession of plantation age existed. Namely, during different development stage, the AMF colonization extends in roots of B. alnoides did not showed the tendency of either increase or decrease with the age of host plant. The AMF colonization rates in the natural forests were always lower than those of B. alnoides in the plantations. However, the AMF spore density showed the tendency of decrease as the age of plantation increase. Soil available phosphorus, total nitrogen and organic matter were the major factors affecting the AM status of B. alnoides, these three factors were negatively correlated with root colonization of hypha and vesicule, and the AMF spore density in the rhizosphere soil.

Email: 1401764297@qq.com

Pests and pathogens increasingly threaten plantation forestry in Asia

Michael J. Wingfield[1], JolandaRoux[2], Chen ShuaiFei[3]
1. Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria
2. Department of Plant and Soil Science, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria
3. China Eucalypt Research Centre (CERC), Chinese Academy of Forestry (CAF)

Plantation forestry based on non-native tree species has expanded rapidly in Asia in the past approximately 30years. This has particularly been through extensive planting of Acacia and Eucalyptus species for the production of wood pulp products. In comparison to other parts of the world, where trees of these genera have been established in plantations, the accumulation of pest and pathogen problems has been remarkably rapid in Asian countries. This is most likely due to the unrestricted exchange of germ-plasm in the form of seed and plant material between countries.

Native pathogens such as the root-rot fungus Ganoderma philippi and leaf-infecting species of Calonectria have imparted substantial damage. But pathogens, most likely introduced from other parts of the world, such as the devastating Eucalyptus leaf and shoot-infecting fungus Teratosphaeria destructans, species of Ceratocystis that cause canker and wilt diseases and most recently myrtle rust (Puccinia psidii) and the gall wasp Leptocybe invasa are of substantial concern. Diseases and insect pests pose a substantial and growing threat to the long-term sustainability of plantation forestry in Asia. There is an urgent need for investment in research and human capacity able to undertake this work. This will lead to the development of disease-tolerant planting stock but perhaps more importantly, a base of knowledge without which plantation forestry in Asia will be difficult to sustain.

Email: mike.wingfield@up.ac.za

Session F-08 (102): Reforming forest tenure and governance in Asia

Has egalitarian allocation of China's collective commercial forest tenure sacrificed the households forestland management efficiency?

Hua Li[1], Can Liu[2], Shunbo Yao[1], Hao Liu[2,] Bowen Wang[1]
1. Northwest A&F University
2. China National Forestry Economics and Development Research Center

Institutional change can alter natural resource and environmental outcomes as well as people's welfare. China has been implementing a new round of forest tenure reform and institutional change. Using large database obtained from comprehensive surveys in five provinces, this paper was motivated to document what is the relationship between the equity and households' efficiency, assess whether the measures taken are appropriate and adequate, and explore what remains to be pursued. Our study has confirmed that in its earlier periods, the property rights reform has achieved the win-win increase of equity and efficiency in the Chinese southern collective forest region,the forestry production has experienced major shifts, the use of factor inputs became much larger and intensive than that of 2003,the TE of farmers' forestry production is increased basically. However, from 2010 to 2011the property rights reform has become the lose-lose decrease of equity and efficiency. Among the factors to influence the TE of in forest production, the length of time from the beginning of the reform to 2011, forestry insurance and forestry loan, have a positive impact on technical efficiency but not significant statistically, forestland transfer and the ratio of off-labor to total labor have a positive impact on technical efficiency remarkably. While the Gini coefficient of forestland, harvest restriction, timber price, and the poor road condition in forestry region has a significant negative effect on technical efficiency. The results imply thatit will be a long and difficult process to adjust or refine these challenges based on local conditions and farmers' adaptive responses. Nonetheless, implemented properly, the reforms will bring about a profound change to the rural economy and forest ecosystemsin China, even the world.

Email: 331 lihua7485@163.com

Session H-8A (36): Illegal timber of the global East: can China and Japan meet their obligations to eliminate unauthorized timber from global supply chains

Asian timber consumer countries and the quest for legal timber in global supply chains

Wilhelmus De Jong
Kyoto University

The problem of illegal timber in Asian forest product supply chains has been recognized since the issue became of global concern, during the late 1990s. In the three major timber consuming countries of Asia, China, Japan and South Korea, steps are being taken towards eliminating illegal timber from supply chains. However, the three countries have still among the highest proportions of illegal timber in their foreign timber imports. Japan has been trying to promote the trade and use of only legal timber in the country by implementing a so called “Goho Wood” system. The system, however, is voluntary for the private sector, and is considered to have design flaws, and thus to be ineffective to stop illegal timber entering into the country. South Korea has since 2013 enacted the Act on the Sustainable Use of Timber that includes countermeasures against illegal timber from Korea or from elsewhere being traded and used in the country. However, no “Enforcement Ordinance” has yet been adopted, an ordinance that would effectively activate the legislation. China has been in the process of developing the Chinese Timber Legality Verification System for some time. The expectation, however, is that the adoptions of the CLTV will be hindered especially by governance issues of the application of the norms, or of the administration of the CLTV in general. In the three countries the private sector is anticipating that legality standards will be raised in most developed consumer countries. In some sectors, companies, or their representative organizations, are actively promoting and even demanding that companies comply with higher standards. When focusing especially on the competences and responsibilities of national governments and their forest agencies, it is surprising that they still have not devised and implemented legislation that further restrains illegal timber from being traded in Asian supply chains. This will be a key instrument that will put pressure on governments of producer countries to more effectively eliminate illegal timber, but it will also become a most helpful tool for those same governments and other actors in the forest sector to effectively implement policies and programs towards a more legal forest sector. The presentation will dwell on efforts, progress and prospective of timber legality verification in Asian consumer countries, link it to efforts of other timber consumer countries and reflect on impacts in timber producing countries.

Email: dejongwil@gmail.com

Efforts of wood identification in China to promote legal logging and timber trade

Yin Yafang[1], Jiao Lichao[1], Yuan Liangchen[2], Zhang Yue[2], Yu Min[1]
1. Wood Anatomy and Utilization Department, Research Institute of Wood Industry, Chinese Academy of Forestry
2. Division of Flora Affairs, CITES Management Authority of China

China is an important destination and consumer market for timber shipments in Asian region and even all over the world. These timber imports and re-exports involve the species of trees that are

listed in the Appendices of CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora). At present, CITES is assigned as an incomparable international regulatory tool in combatting illegal logging and its related trade. To date, more than 250 timber species have been listed in the CITES Appendices. China has always placed emphasis on the conservation and sustainable use of timber resources by strictly implementing the Convention and by improving the law enforcement for cracking down on illegal trade and trafficking. However, the rapid inclusion of timber species in the CITES Appendices for control pose a formidable challenge to the implementation of the Convention, since it requires an accurate identification of timber species that are subject to international trade. With a keen understanding of this problem, in this paper, we provide recent explorations and future prospects of wood identification technologies based on wood anatomy and DNA barcodes in China.

Email: yafang@caf.ac.cn

Timber legality and forest sustainability in Malaysia

Daisuke Naito
Kyoto University

The Asian timber sector, there is a much pressure to move towards a more legal and sustainable timber production. Civil society organizations and European and American NGO are pressuring, international and bilateral development cooperation is facilitating the process. Japanese government is also moving towards meeting global standards of due diligence, and social and environmental responsibility in timber trade, however, current Japan's Goho Wood System can accept self-assuarance and any kind of certification. While Malaysia have been established Malaysia Timber Certification Scheme and also introduced FSC certification, already have certified around 30% of is own forest. Malaysia also participated FLEGT VPA process and claimed to have a comprehensive legality verification system. Forest certification and FLEGT applies mostly in Peninsular Malaysia and Sabah. It is important national governments, sector agencies and other support organizations in producing countries do need to pay much attention to possible negative impacts of quick and more effective legality verification and legality compliance, and adjust regulations and administrative procedures to make sure that smallholders and local communities do not suffer, but rather can benefit from a more legal and sustainable management of forest.

Email: dnaito@gmail.com

The analysis of illegal logging situation and its governance policy in ASEAN

Guan Zhijie[1], Gong peichen[2]
1. Changzhou University
2. Swedish University of Agricultural Sciences

Illegal logging has become a serious problem in the fields of forest management in ASEAN. In the paper, the authors analyzed the definition of illegal logging firstly, and based on this, they reviewed the present situation of illegal logging in ASEAN, explored its cause. Then the authors evaluated the governance policy and its effect in ASEAN. Finally, the authors suggest that governing illegal logging in ASEAN should take measures together as a regional group, and in the view of ASEAN as one regional group suggest ASEAN should establish cooperation mechanisms within the region, take governing illegal logging as a unified external action, build its own "Forest Law Enforcement, Governance and Trade Action Plan" and ASEAN should promote enterprises forest certification.

Email: zhijie.guan@163.com

Illegal timber global east early warning by remote sensing monitoring technology

Deng Guang
Chinese Academy of Forestry

Volume of illegal wood-based products being imported into China, according to Laura Wellesley's report, these are reckoned to comprise 17 percent of the total by volume in 2013.China government plans to establish bilateral trade agreements with producer countries to reduce the illegal timber import. But if the original illegal logging cannot be early monitored, the illegal timber will come onto the market all as the same. All the system and agreements in circulation an exchange domain to stop illegal timber is like to mend the fold after the sheep have been stolen. More serious is that circulation domain actions need huge manpower、money and risk. Now days Internet Plus and remote sensing monitoring technology can keep on monitor the key natural forest region and hot area. This paper puts up a new Internet plus based system framework and then presents an example to monitor the illegal logging in domestic China natural forest area to show its practicability. We use GF1 and GF2 satellite data to do this and proposal an international cooperation first from China and Japan then to the east Asia for illegal wood logging early warning.

Email: dengguang@ifrit.ac.cn

Promoting legality and sustainability of timber production through exports to Asia? Insights from Cameroon and Gabon

Guillaume Lescuyer[1,2], Louis Putzel[2], Edouaed Essiane Mendoula[2], Samuel Assembe Mvondo[3], Marie-Luce Bia Zafinikamia[4]
1. CIRAD
2. CIFOR
3. COMIFAC
4. University Paris I

The evolution of the international market of tropical timber is marked by two major trends. On the one hand, Asian countries become the main importers of this commodity. On the other hand, these products have to deal with the (public and private) requirements of legality and sustainability. This article analyzes how the increase of timber exports to Asia has facilitated the legality and sustainability of this production in Cameroon and Gabon. This study combines a review of export statistics, a literature review and interviews with 12 private companies that export to Asia.

This analysis is done in three steps. We first show that Asian companies have had diverse investment strategies to strengthen their presence in Central Africa. They benefited from a favorable institutional environment, in which timber legality verification remains a general issue regardless of end market. We then recall the evolution of timber exports from Central Africa to Asia. The increase in volume of exports was accompanied by a diversification of exploited species, although some of these species have been illegally harvested and traded. Finally, timber exports to Asia are subject to only minimal verification of legality (by the simple control of official documents) and do not meet a specific requirement of sustainability. Asian demands are very little known by exporting companies based in Central Africa because they supply these markets through brokers, without knowing how their products are used in downstream activities.

Overall, Asian markets have so far not provided an opportunity to improve the legality and sustainability of timber production in Central Africa, but some companies have developed the skills to respond quickly to such requests if they were to emerge in the coming years. However, the central role of brokers in this trade prevents the Congo basin-based companies from directly sensitizing the Asian domestic demands to promote their certified products.

Email: g.lescuyer@cgiar.org

Session H-8B (98): Forest-based sustainable bioenergy in Asia and the Pacific

Biofuel content and their physical-chemical properties of *Calophyllum inophyllum* from 7 islands in Indonesia

BudiLeksono
Centre for Forest Biotechnology and Tree Improvement

The global energy crisis has raises demand for biofuel prices. It has driven the world to enhance environmentally-friendly renewable-energy (biofuel) production. Oil from the seeds of *Calophyllum inophyllum* (nyamplung) which can be harvested up to 50 years, is one of such potential biofuel source. Methods for biofuel production from nyamplung seeds have been developed at an industrial scale by Energy Self-Sufficient Villages in Indonesia. However, there is only a limited-information available on biofuel content, in term of productivity and quality, from nyamplung populations.This paper reports the biofuel content among 12 populations of 7 islands in Indonesia. The oil was extracted using a combination of vertical hot press (VHP) and screw press expeller (SPE) methods, followed by degumming to make refined oil, and esterification-transesterification to turn it into biodiesel. The result show great variation of biofuel content among the population. Oil production percentage varies from 37-48,5% (VHP) and 50-58% (SPE) crude oil, 36-48% (VHP) and 40-53% (SPE) refined oil, and 17-33% (SPE) for biodiesel. All of 18 properties tested vary and most are in line with international standard of biodiesel. DNA analysis shows genetic variation among populations ranges from intermediate to high and intermediate within populations. The informations are important factors for establishment of genetically-improved seed-sources for biofuel.

Email: boedyleksono@yahoo.com

Potential of bio-energy for fulfilling energy and food demand in Pakistan

Tariq Aziz[1,2], Khalid Mehmood[3], Nils Borchard[4], Aamer Maqsood[1], Munir Zia[5]

1. University of Agriculture
2. University of Western AUS
3. Research Centre Juelich
4. CIFOR
5. Fauji Fertilizer Company

A continuous and reliable source of energy is needed for sustainable industrial growth and living standards of the population. Pakistan is facing acute shortage of energy which adversely affected industrial as well as agriculture sector particularly during last decade. Renewable energy is the most suitable alternate which has gained serious attention in the world as well. Being agriculture based economy, Pakistan has potential to produce energy from biomass with about 26 million hectares of land under cultivation. As per estimates the potential from bio-energy sources is expected to be 50GW in 2015. To harvest this potential, modified agricultural land use and soil management systems are needed to cope with degrading the soil and environment. Moreover, the bioenergy plants produce by-products (organic waste) which should be considered both for environmental reasons and dumping off. The use of bio-energy by-products may enhance crop yields and help in coping with climate change by sequestering carbon thus fulfilling the needs for both energy and food. In this way bio-energy by-products can contribute to agricultural growth and thus poverty reduction in developing countries due to improved productivity while managing soil carbon stocks.

Email: draziz@uaf.edu.pk

Sustainable utilization of biomass for energetic purposes

Walter Stinner[1], Ronny Wirkner[1], Khalid Mehmood[2], Nicolai David Jablonowski[2], Nils Borchard[3]
1. German Biomass Research Centre
2. Forschungszentrum Juelich GmbH
3. Centre for International Forestry Research

Bioenergy is a multi-purpose player for the heat, process energy, traffic and electric energy sector. Due to the storability in solid, liquid and gaseous form it is predestinated to balance the fluctuating wind and solar power. In cooperation with international partners, DBFZ develop and execute research and demonstration projects in many countries with a focus on i) systemic market and biomass assessments, ii) development, adaptation and evaluation of technologies on demand & infrastructure, iii) developing sustainable bioenergy strategies. There is a further need for optimized bioenergy-agro-forestry systems especially in the tropical and subtropical regions, naturally covered by forest. A high efficiency and productivity of this bioenergy-agro-forestry systems is needed, to supply the rising needs of the population in these regions without enhancing the pressure on intact forests. Key factors for this development are multi-fold: i) high efficient biochemical and thermochemical units for variable residual feedstock, ii) integration into demand oriented combined energy supply systems (e.g. with solar power), food supply chains, especially for post-harvest technologies to reduce losses, iii) closing of nutrient cycles and enhancement of nutrient efficiency by integration of digestate and charcoal-ashes and iv) integration of cropping elements, combining bioenergy production with positive impact for the agro-ecosystems.

Email: Walter.Stinner@dbfz.de

Potentials of tropical woody crops for soil restoration and bio-energy production in Indonesia

NilsBorchard[1], HimlalBaral[1], Soo MinLee[2], EdiWiraguna[1,3], AchmadSolikhin[1,3],Lilik BudiPrasetyo[3]
1. Center for International Forestry Research
2. Korea Forest Research Institute
3. Bogor Agricultural University

Indonesia is facing a crisis in energy needed to meet the demands of growing population, urbanization and economic development, as well as it's goals in reducing Greenhouse emissions. Although there are potential resources to meet these food and energy demands, this will bring major challenges in both sustainable land management and in implementation of modern technologies. There is growing awareness that restoration of degraded ecosystems could provide a pathway towards producing biomass that can be converted to bio-energy. Here we provide a decision making tool, by combining spatial soil information (on degradation and soil properties) and plant growth factors (i.e. suitability) of potential woody bio-energy crops. This tool would be valuable in managing soil restoration activities, and hence in facilitating production of bio-energy across scales in Indonesia. Consideration of plant suitability can help optimise biomass productivity and associated production of bio-energy in different areas and zones.

Email: N.Borchard@cgiar.org

Harmonization of bioenergy conversion technologies for establishing sustainable energy production system

Soo MinLee[1], HimlalBaral[2], NilsBorchard[2], Han SeobJeong[1], Jae JungLee[1]
1. National Institute of Forest Science
2. Center for International Forestry Research

Facing new era of climate change issue since Paris agreement 2015, biomass and bioenergy is considered to get another ramping-up chance as valuable renewable resource. Biomass can produce heat and electricity through combustion process like coal and fossil oil. In terms of renewable energy production, it is similar to other renewable energy resources such as photovoltaic, hydroelectric, and geothermal system. Biomass, furthermore, has other unique characteristics that other renewable energy resources don't have. Biomass can be transformed to various types of biofuels by biological and chemical processes, and substitute fossil-based chemical raw material. Despite recent technological development of biomass transforming, however, there are still several issues remained in many local communities of Asia to realize the impact of biomass utilization on site and secure the sustainability of production system. To achieve these goals, appropriate technologies and its' harmonization need to be considered under different environmental and socio-economic conditions of each local community. In addition, the improvement of process efficiency is also required in order to increase production yield, reduce greenhouse gas emission and substitute fossil oil based products to biomass based material. In this study, the concept of harmonizing different biomass conversion technologies is discussed to deliver the socio-economic impact on local community.

Email: lesoomin@korea.kr

Sustainable bioenergy production from community-managed forests in Nepal

Bishnu HariPoudyal
The Center for People and Forests, RECOFTC Nepal

Community Forestry (CF) is becoming a popular approach for restoring the landscapes and supporting livelihoods globally. Nepal has remained in the forefront of CF which initially aimed at supplying of basic forest products including firewood, fodder, and leaf litters. Recently, the livelihoods strategy of communities has significantly shifted which caused underutilization of these products and this has been a key issue posing threats of forest fire in the Community-managed Forests (CMF). Sustainable and diversified use of biomass is, therefore, an urgent requirement in CMFs that can also support fulfilling the increasing energy demand and reducing greenhouse gas emissions.

Drawing lessons from existing community-based bioenergy projects, this paper aims to: (i) identify potential opportunities to utilise biomass produced by CMF for bioenergy production at local scale and (ii) explore socio-economic and environmental benefits/costs including potential risk and challenges associated to bioenergy production from CMF. Combination of participatory approaches such as, transect walk, semi-structured interviews and focus group discussions will be used. A model of forest-based bioenergy production system could be developed that significantly reduces the forest fuel thereby reducing the frequency of forest fire and its impacts. The study highlights the potential challenge of overharvesting of biomass in CMFs.

Email: bishnuharipaudel@yahoo.com

Biodiesel production from calophyllum inophyllum and it's waste utilization

BudiLeksono
Centre for Forest Biotechnology and Tree Improvement

Biodiesel as an alternative fuel for diesel engines is becoming increasingly important due to diminishing fossil reserves and the environmental consequences of exhaust gases from fossil-fuelled engines. The utilization of liquid fuels such as biodiesel produced from *Calophyllum inophyllum* (nyamplung) oil by esterification-transesterification process represents one of the most promising options for the use of conventional fossil fuels. The seeds of nyamplung to be biodiesel through the process of pressing seed, degumming, esterification, transesterification, washing and drying. Pressing seed for extracting oil (crude oil) from nyamplung seeds using screw press machine. Degumming is the process of separating oil and gum from crude oil produce. Esterification is a reaction process of changing Free Fatty Acid (FFA) into Fatty Acid Methyl Eter (FAME) compounds and transesterification is a reaction to change triglyceride into FAME compounds. Transesterification content was set to separate oil (crude biodiesel) and glycerol. In producing biodiesel, crude biodiesel needs to be washed and dried until the water was clear and wet biodiesel with high moisture content looks blurry. With the concept of 'zero waste', the utilization of both solid and liquid wastes can be used for charcoal briquette, charcoal compost, feed, liquid smoke, medicinal, cosmetics and soap to increase economic feasibility of biodiesel manufacturing from nyamplung oil.

Email: boedyleksono@yahoo.com

Worldwide growth in renewable energy and the contribution of bioenergy/biofuels

Jinguang Hu, Susan van Dyk, Jack Saddler
University of British Columbia

As described in the most recent update of the International Energy Agency's (IEA) World Energy Outlook, global energy demand will likely grow by 37% by 2040. The vast majority of the growth will occur in China, quickly followed by India, Southeast Asia, the Middle East and sub-Saharan Africa. Renewable energy (RE) will play an increasing role, with RE accounting for almost half of the world's increase in total electricity generation by 2040 and the use of renewables for heat doubling while the use of biofuels predicted to triple to 4.6million barrels/day.

While OECD countries remain a driver of renewable power development, non-OECD countries are increasingly accounting for overall growth. Over the last decade the cost of some renewables, solar in particular, has dropped significantly, although the intermittent nature of these forms of renewables has prompted the ongoing search for cost effective energy storage devices. This is one of the significant advantages of biomass, with the pellet sector showing how it can be readily integrated into much of the coal fired power sector. One of the challenges with bioenergy/biofuels is the cost, location, availability and sustainability of the biomass feedstock. At a "high level", solar and wind are predisposed to making electricity while biomass is preferentially used for heat and biofuels applications. Countries such as China already use biomass in "traditional" applications such as for cooking and charcoal production. However, the transitions from "traditional" to "advanced" biomass applications (i.e. combined heat and power (CHP), biofuels, etc.) does not readily occur, with fossil fuels predominating as standards of living increase. As will be covered in the latter parts of the presentation, despite these challenges, some applications such as aviation, shipping and long distance trucking have no real alternative than the development of cost effective, sustainably derived biofuels. IEA Bioenergy Task 39 has been, and continues to investigate the challenges and potential of technologies for producing drop-in biofuels. The report published in 2014, "The potential and challenges of drop-in biofuels" (www.Task39.org), is currently undergoing an update. There continues to be, considerable interest in developing biofuels that can be readily integrated into the existing petroleum fuel infrastructure in a "drop-in" fashion, particularly by sectors such as aviation where there is no alternative, sustainably produced, low carbon emitting fuel source. Although most drop-in biofuels will be produced via the oleo chemical route, (i.e. the hydro processing of lipid feedstocks), in the longer-term, biojet production will likely be based on lignocellulose feedstock using thermochemical platforms (pyrolysis/HTL/gasification).

Canada has vast forest resources and an innovative forestry industry that could potentially support an evolving biojet sector. British Columbia has been at the forefront of increased wood residue utilization as exemplified by the established pellet sector. The University of British Columbia has been working with partners such as Boeing, WestJet, Bombardier, skyNRG, Air Canada and Noram Engineering to assess the viability of producing biojet from forest residues. This project will also be briefly described.

Email: jinguang@mail.ubc.ca

Session I-8A (72): Gender competence for forestry, natural resources management and wood industry

Gender issues in education of foresters and natural resource managers in disaster risk reduction

Maria Papathoma-Köhle, Christina Paulus, Barbara Hinterstoisser
University of Natural Resources and Life Sciences, Vienna, Austria

According to UNISDR mainstreaming gender perspectives into disaster risk reduction (DRR) is a fundamental pillar for sustainable development. Many aspects of DRR are closely related to forestry and natural resource management - a still male dominated field. Foresters and natural resource managers have to deal with the impact of a wide range of catastrophes (e.g. wild fires and floods) and by that playing an increasing role in DRR. Therefore, lifelong learning in DRR issues is essential issue. Moreover, continuing education in DRR should include gender issues such as empowerment of women, female vulnerability to natural hazards and gender inclusive crisis communication. The aim of the paper is to outline the gender issues in research and education for women working in the field of DRR, inform about the launching of a new European network ("Women exchange for Disaster Risk Reduction" we4DRR) and present its short and long term goals. The network was initiated and organised by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) and the University of Natural Resources and Life Sciences Vienna (BOKU) and was launched in Austria in March 2016. Its aims to include empowerment of women, mentoring of young female professionals, collecting data on gender and DRR and increasing the visibility of gender-specific aspects in DRR.

Email: Maria.papthoma-köhle@boku.ac.at

Impact of process innovation on the workers in forest products enterprises: gender aspects

Yu Na, Siegfried Lewark, Shen Liming
Nanjing Forestry University

Innovation is a key for forest products enterprises to assure sustainable development. Innovation is defined in three ways: product innovation, process innovation and business systems innovation. In the last decades, the fast development of China's forest products industry mostly benefited from its manufacturing aspect. Thus, implementing advanced manufacturing technologies was considered an important method to assure sustainable development. Aiming to explore the potential of personnel in the process innovation, we evaluated the work satisfaction of the participants in the process innovation in two cycles of a survey in four Chinese furniture firms during one year. General satisfaction, security satisfaction, social satisfaction, supervisory satisfaction and growth satisfaction of workers have been assessed by using the Job Diagnostic Survey (JDS). Results of the study reveal that there are gender differences in work satisfaction of the employees during the process innovation. Especially in the continued improvement phase, work satisfaction of female workers is significantly higher than the values of male workers. The study suggests that improving work satisfaction of employees with considering gender issues could offer contribute to benefit in the success of process innovation in China's forest products manufacturing firms.

Email: yuna96@hotmail.com

Forest management certification and national indicators, needs and options for gendered approaches

Marion Karmann[1], Ma Lichao[2]
1. FSC International
2. FSC China

Currently, there is demand for highly educated professionals with an extensive knowledge of forestry and timber, and one of the several specialist areas that are particularly sought is certification. With version 5 of the FSC Principles and Criteria (P&C) FSC introduced direct gender mainstreaming requirements, for example in criterion 2.2 “The Organization shall promote gender equality in employment practices, training opportunities, awarding of contracts, processes of engagement and management activities.” Members of FSC working groups developing nationally adapted indicators for the global FSC P&C, as well as forest managers implementing these indicators, need an understanding about gender issues in their professional field, to be able to identify and overcome related challenges, e.g. for employment strategies. Likewise auditors, to monitor adherence of forest operations with FSC standards, need to be gender sensitive.

The paper gives examples for gender related requirements in FSC standards relevant in Asian countries, for implications for forest management, and for auditors’ competencies e.g. related to public and workers’ consultations. ISEAL’s requirements for consideration of gender issues in social and ecolabel certification schemes, including the living wage approach, will be presented. Needs for forest education as well as for research will be discussed.

Email: m.karmann@fsc.org

Session I-8B (85): Future for nature-based recreation and tourism

Application of Payment for Ecosystem Services (Ecotourism) in managing protected areas of Bangladesh

Md. Shams Uddin
Winrock International

Payment for Ecosystem Services (PES) is thought to be a suitable management option for the institutional and financial sustainability of Protected Areas (PAs). This paper presents the potential challenges and strategies to implementing ecotourism as a means of PES in three PAs of Bangladesh. This study draws on different studies, government records and field surveys. It reveals that all elements of the PES market models are present in the PAs of Bangladesh. Namely, providers (forest department, tour operators, local community) and buyers (tourists and other resource users). Nevertheless, despite the sustained growth of ecotourism, PES-based management schemes are not adopted in institutional and financial mechanisms of PAs. Key informants suggest that current ecotourism management practices can be turned into PES schemes through proper valuation of ecosystem services of PAs and adopting PES-related policy and institutional mandates for stakeholders (public, private and communities). This will need to include improvements in infrastructure, and defining roles of the providers and buyers for ensuring ecotourism services and benefit-sharing. The findings from this study provide new insights for policy makers implementing PES through ecotourism for better ecosystem conservation in Bangladesh.

Email: msuddin.shams@gmail.com

Future of nature-based recreation and tourism in Finland

Tuija Sievänen, Marjo Neuvonen, Tuomas Nummelin, Seija Tuulentie
Natural Resources Institute Finland

Recent changes in tourism and recreation have been driven by socio-demographic shifts, increases in disposable time and incomes, technological changes, transport developments, decreasing environmental quality and emerging systems of policy and governance. All these changes put pressure for agencies to better understand the on-going changes and also to anticipate better what the future will be and what kind of demands are expected. The aim of this study was to identify the different driving forces in the society and trends in outdoor recreation, and to capture the insights and understanding of alternative futures among the actors working in the field of nature-based recreation and tourism in Finland. Three workshops were organized in 2015. The workshop material consisted of pre-materials (two web-surveys) and structured discussions including the use of future table technics. The time perspective was 2030. The three workshops produced nine different alternative futures for nature-based outdoor recreation and tourism, of which most were described to have positive development for outdoor recreation. Only one was clearly interpreted as dystopia, which should be prevented. The most important means to support equality of access to nature and, and a fair distribution of health and wellbeing benefits from nature to all, were land use planning.

Email: tuija.sievanen@luke.fi

Air pollution and public health: evidence from forests absorb smoke and dust emission in China

Zhou Haichuan, Ye Bing
Research Institute of Forestry Policy and Information, Chinese Academy of Forestry

【Objective】This study empirical exams the impact of respiratory disease associated with dust to residents, quantitative analysis of the relationship between air pollution on public health.【Method】A literature review and qualitative analysis were conducted to explore air pollution caused by respiratory-related diseases, forest affect human health by reducing air pollutants. In addition, using Panel Data from China, a quantitative analysis was carried out to estimate the effect on public health of dust By OLS, panel model, 3SLS.Especially, Using 3SLS overcome endogeneity caused by emissions of particulate matter, thus more accurately evaluate assessment of the negative impact of environmental pollution on public health, valid explanation regional heterogeneity. Finally, using different emissions as an instrument to estimate the robustness of the results, ensure the reliability of conclusions【Results】1) OLS estimates show that the impact on public health of dust is very significant, smoke and dust emissions increase 1%,the number of people dying from lung cancer and respiratory diseases corresponding increase 0.568% and 0.488%. 2) A random effects model (RE) show that Lung cancer deaths caused by the smoke and dust decreased significantly, significantly positive for deaths of respiratory diseases at 10% level,

smoke and dust emissions increase 1%, the number of deaths will increased 0.207% and 0.467%, respectively.3) Using the area of pests and diseases as an instrument of forest area， which solve endogeneity smoke and dust emissions. Based on 3SLS, This study shows that forest area significantly affect smoke and dust emission, forest area increase 1%, smoke and dust emissions will increase 0.884% approximately. Smoke and dust emissions increase 1%, the number of people dying from lung cancer will increase by 0.777%, deaths from respiratory diseases will increase by 0.704%, the value were higher than OLS, random effects model estimated, which shows two methods underestimate the impact of air pollution on public health. 4) The per capita GDP and population density will positive effect on public health, health expenditure per capita for residents negative effect on public health at 1% significance level, per capita health expenditure increase 1%, the deaths with lung cancer and respiratory will decrease 0.362% and 0.543%, respectively. Forest will improve the level of public health by absorbing smoke and dust emissions. In order to improve the level of public health, Not only control pollution from the source through legal and enforcement measures, but also promote vigorously afforestation, increase forest cover, expands smoke and dust absorption, effectively improve the level of pest control.

Email: yb70@caf.ac.cn

Session A-9A (65): Forest adaptation and restoration under global change-Asian and Oceanian perspectives

Forest landscape restoration as a strategy for mitigating and adapting to climate change

John Stanturf
US Forest Service

The global magnitude of degraded forests and deforested areas is best approached by restoring landscapes. Most opportunities are mosaic restoration in the Tropical and Temperate Zones where human pressure is moderate. A rapidly changing global environment introduces uncertainty, however, that questions the usefulness of success criteria based on present or past ecosystems conditions. Adaptive strategies for coping with climate change may be incremental, anticipatory, or transformational. These approaches to reducing vulnerability and increasing adaptive capacity differ in their future orientation but share similar objectives of favoring genotypes adapted to future conditions; resisting pathogens; managing herbivory to ensure adequate regeneration; encouraging species and structural diversity at the stand-level, landscape-level, or both; and providing connectivity and reducing fragmentation. Incremental adaptations are often characterized as “no-regrets” where the benefits are realized under current climatic conditions, as well as providing some adaptation to future conditions. Anticipatory approaches use many of the same techniques as incremental approaches but with an eye toward adaptation to future climate, thereby tolerating more ecological novelty. Transformational approaches proactively seek to anticipate and respond to changed conditions. Integrating attempts to restore landscapes and mitigate and adapt to climate change may synergistically increase adaptive capacity.

Email: jstanturf@fs.fed.us

A task force on forest adaptation and restoration – concept and pathways

Andreas Bolte
Thünen Institute

Forests and forest landscapes worldwide have to face global change, including climate change, in particular with extreme weather events (disturbances), novel and changing pathogen impacts, and changing social demands for forestry and land use due to increased demands for meat and diary, bioenergy production, and environmental services. In the face of these challenges, there is an increasing need for forest ecosystems and forest landscapes adapted and adaptive to varying demands on ecosystem services and changing environments.

The IUFRO Task Force "Forest Adaptation and Restoration under Global Change" is dedicated to globally compile and improve knowledge how to achieve an optimal adaptation status of forest and forests landscapes. We are introducing the Adaptive Measure (AM) approach: considering all actions that increase adaptive capacity of forests and forest land combining Adaptive Forest Management (AFM) concepts on stand-scale with Forest Landscape Restoration (FLR) concepts on landscape scale linking national and trans-national politics, as well as trans-disciplinary expertise in various fields of forest ecology, silviculture, forest restoration, genetics, social science and politics, and integrating experts and working activities among various IUFRO sections.

The Task Force's conceptual pathway work is following three aims: (1) identifying knowledge gaps, (2) comparing existing activities and techniques, and (3) elaborating best practice approaches. The work plan includes:

Retrospective knowledge (gap) analyses
Continental/regional workshops - state of the knowledge reviews
Collaborative compilation and analyses
Data compilation and meta-analyses, storage in central open database
Conception and implementation of research and monitoring networks on AM
Joint research needs and concepts, methods and activities
Elaboration of best practice approaches
Compiling results and experiences, elaborating best practice examples.

The continental/regional workshops are core activities that are planned to take place on five different continents. This Task Force will be focussed on scientific activities, and the group is open to any new partner/contributor within IUFRO or outside. Thus, the applying group is meant as an initial group that should be completed with other persons during the ongoing work. It is planned to collaborate and network with other scientific and political organisations, networks and groups within IUFRO and outside.

Email: andreas.bolte@thuenen.de

Effects of climate and thinning on individual tree diameter growth and mortality of semi-natural Larch-spruce-fir forests in Northeast China: 25years results

Lei Xiangdong
Chinese Academy of Forestry

Climate change and thinning are expected to affect tree growth and mortality. However, there is still a gap on their interacting effects. In this study, we examined effects of climate and thinning on individual tree diameter growth and mortality. Tree growth data is from 20 sample plots of semi-natural larch-spruce-fir forests repeatedly measured from 1986 to 2010 in northeast China. Using generalized additive mixed model(GAMM), we showed that tree diameter growth increased with increasing thinning intensity, but the effect become less with the time after thinning. Mortality was lowered with increasing thinning intensity. Competition had negative and positive effects on tree growth and mortality, respectively. Climate variables including accumulated temperature above 5°C in growing season(GSDD5), mean minimum temperature in growing season(GSMT), mean annual precipitation in growing season(GSMAP), and mean temperature difference between coldest and warmest months(TDIFF) had complicated nonlinear relationships with diameter growth and mortality. Climate-growth/mortality relationships were also modulated by thinning intensity and tree species (group). These results will be of help in developing guidelines for adapting forests to future climate change.

Email: xdlei@ifrit.ac.cn

Challenges of restoration and adaptation in Hindu Kush- Himalayan Mountain region

Promode Kant[1], Wu Shuirong [2]
1. Institute of Green Economy, Gurgaon NCR, India
2. Institute of Forest Policy and Information, Chinese Academy of Forestry, Beijing

The Hindu Kush-Himalayas, spread over 354 million ha and eight countries including five Least Developed Countries (LDC), are one of the most ecologically and hydro-logically sensitive regions on the earth. Almost a quarter of these mountains are covered with forests under varying degree of degradation, 37.5% are pastures and 5.4% agriculture while protected areas constitute about 2.5%. Receding glaciers and glacial lake outbursts, torrential rains and landslides, prolonged droughts, increased severity and incidences of forest fires, floral and faunal migrations to higher altitudes, and lowered productivity of Non Timber Forest Produce due to progressively suboptimal climatic conditions, need urgent adaptive responses. Largescale forest degradation is both a cause and consequence of widespread poverty but lack of financial resources inhibit adequate investment in forest restoration in LDCs compounded further by uncertain political situation in some. Inappropriate policies and widespread institutional limitations to channelize human and financial resources present humongous problems. This paper offers an overall view of the core challenges of forest restoration and adaptation to climate change in these mountains and suggests ecological and economic considerations for prioritization of forest landscape restoration and of preventive, curative, and damage limiting measures. The ways in which the international institutional support can ease these challenges have also been discussed.

Email: promode.kant@gmail.com

Is local best - do local trees perform better than other trees?
– results from a systematic review

David Boshier[1,6,2], Linda Broadhurst[2], Jonathan Cornelius[3], Leonardo Gallo[4], Jarkko Koskela[5], Judy Loo[6], Gillian Petrokofsky[7], Bradley St Clair[8]
1. Dept. of Plant Sciences, University of Oxford, South Parks Road, Oxford, OX1 3RB, UK
2. CSIRO National Research Collections Australia (NRCA), Centre for Australian National Biodiversity Research (CANBR), GPO Box 1600, Canberra, ACT 2601, Australia
3. World Agroforestry Centre (ICRAF), CIP, Apartado 1558, Lima 12, Perú

4. INTA, Bariloche, Argentina
5. FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy
6. Bioversity International, Via dei Tre Denari, 472/a, 00057 Maccarese, Rome, Italy
7. Dept. of Zoology, University of Oxford, South Parks Road, Oxford, OX1 3RB, UK
8. US Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way Corvallis, OR 97331, USA

Planting of native trees for woodland production, habitat conservation, restoration and other purposes on farms depends on a ready supply of germplasm (seeds or vegetative material), which in turn requires consideration of what is the best or most appropriate source of seed. Although 'what was available' often determines what is planted, choice of seed source, both in terms of its location and genetic composition, can have important consequences for the immediate success and long-term viability of plantings. Use of local provenance planting stock is often emphasised (e.g. in forest certification and timber labelling standards), or even tied to financial aid for tree planting. However, discussion about suitable seed sources of native trees often emphasises "local" in a narrow sense or within political boundaries, rather than using scientific evidence. Concerns exist over the scale (magnitude and spatial) of adaptation in trees. Undue emphasis on local seed sources or poor practice in seed collection may drive sourcing from small stands or a limited number of trees, producing populations that are unlikely to be both adapted and adaptable and therefore with limited potential for long-term persistence, particularly in the face of climate change.

Provenance field trials in many parts of the world have shown the existence of genotype by environment interaction in many tree species, but have not necessarily looked at whether the local seed source performs better. We reviewed published data from such trials to examine the evidence for local adaptation and its scale in a number of native tree species from different trial sites across the globe. We highlight results from Asia and Oceania and discuss evidence gaps and how the findings could help inform current and future policy on seed sourcing for tree planting and forest restoration in a variety of contexts.

Email: david.boshier@plants.ox.ac.uk

Session A-9B (99): REDD+ between transformational change and business-as usual – lessons from 7 years of global comparative analysis

REDD+ in Indonesia: a project or new mode of governance?

Moira Moeliono, Efrian Muharrom, Maria Brockhaus, BimoDwi Satrio, Cynthia Maharani
Center for International Forestry Research (CIFOR)

Indonesia was an early adopter of developing a REDD+ policy, prior to COP 13 in Bali in 2007. However, REDD+ from a simple idea to offer incentives for those reducing deforestation and forest degradation, was revealed to be a complex and time consuming process involving numerous actors and interests. Actual implementation has been slow. Yet, a survey conducted in 2015, indicated that REDD+ activities increased awareness on forest, forest loss and climate change and put forest governance on the development agenda during Indonesia's previous government. In 2015, a new government, new institutions and new decentralization laws diverted REDD+ policies. This paper uses a longitudinal study comparing results from a survey done in

2012 with one from 2015, to analyze how these changes are influencing the REDD+ and forest governance processes. We specifically attempt to understand how power relations with regard to REDD+ has changed and whether transformational change in forest governance have occurred. Results show changes in how actors relate to each other and how REDD+ policy is linked to decentralization and recentralization but yet remains a ‘development project’ rather than a new mode of governance. Transformational change remains elusive but REDD+ has contributed to introduce seeds for change.
Email: m.moeliono@cgiar.org

Multilevel governance challenges of altering land use change trajectories: technical solutions to political problems in REDD+ and non-REDD+ land use changes

RoddMyers[2,1], AnneLarson[1], Ashwin Ravikumar[1]
1. Center for International Forestry Research (CIFOR)
2. University of East Anglia (UEA)

Understanding the politics of land use change is challenging in part because there are so many different actors and interests involved. Yet, it is imperative (especially as REDD+ moves to implementation) to understand how these different actors work together – or in opposition – to produce land use changes. We conducted over 700 interviews with actors in Indonesia, Vietnam, Peru, Tanzania and Mexico. We asked: (1) Across levels and sectors, how and why are land use decisions made? (2) Are investments and interventions in reducing carbon emissions leading to changes in land use decisions, and if not, why? and (3) What are the challenges to and opportunities for bringing about transformational change?

This presentation focusses on research in Indonesia and draws comparisons to our findings in other countries with particular reference to REDD+. We found that (1) despite diverse legal systems and varying levels of decentralisation, powerful actors with a stake in deforestation seemed to find ways to benefit disproportionately to other actors; (2) there are institutional and political barriers to change in land use trajectories that render technical solutions inadequate to curtail ‘undesirable’ land use changes; and (3) regardless of the strengths or weaknesses of safeguards and policies, the proclivities of individuals played a significant role on how policies were, or were not implemented, leading to varying extents of processes and outcome legitimacy.

Email: rodd.myers@uea.ac.uk

Assessing equity risks of REDD+ benefit sharing within national policymixes

GraceWong[1],Maria Brockhaus[1], LasseLoft[2],Thu ThuyPham[1],AnastasiaYang[3]
1. CIFOR, Indonesia
2. Leibniz Centre for Agricultural Landscape Research, Germany
3. Thünen Institute of International Forestry and Forest Economics, Germany

This paper presents a framework to address these complexities and assess potential risks to performance in three areas: (1) how beneficiaries are selected and the targeting criteria countries implement REDD+, how the benefits are shared and allocated will influence performance in meeting the objectives of emissions reductions and provision of social and environmental co-benefits. A REDD+ benefit sharing mechanism operates within a constellation of national contexts, institutional factors and policies beyond the forest sector, making any evaluation of such a policy instrument a complex task. (2) the broader institutional and policy contexts underlying forest and REDD+ governance; and (3) outcomes of REDD+ including emissions reductions and co-benefits. In applying the framework to benefit sharing mechanisms and governance in forestry sector in Vietnam, we gain insights into trade-offs between the carbon effectiveness, cost-efficiency and equity, and particularly where equity risks may emerge. The framework provides flexibility in use of indicators that are context-appropriate to allow for a common understanding of what needs to be assessed. This will be important features as countries identify and negotiate indicators for measuring performance to justify and trigger results-based payments in the post-Paris arena.

Email: g.wong@cgiar.org

Objectives, engagement and ownership in Lao PDR's REDD+ policy landscape

RobertCole[1,2], GraceWong[2], MariaBrockhaus[2], MoiraMoeliono[2], Maarit Kallio[3]
1. National University of Singapore
2. CIFOR
3. University of Helsinki

Reducing Emissions from Deforestation and forest Degradation (REDD+) is envisioned as a performance-based incentive to influence forest use behaviour and governance, by assigning tangible value to the preservation and management of standing forests. In relatively forest-rich Lao PDR, the policy space that REDD+ planners are attempting to navigate is populated by enduring political and economic interests, and potentially divergent objectives that affect the country's forest estate. A further layer to the problem of REDD+ planning is the tension between often expert-driven, externally proposed solutions; national ownership over interventions; and the extent of political will to take action to reform currently unsustainable patterns of forest and forest land exploitation. This paper draws from a policy networks analysis approach based on in-depth semi-structured interviews to examine and contrast the diverse interests and objectives, planning approaches and engagement strategies among of government, international and private sector actors in Lao PDR's REDD+ process. While internationally-driven projects follow long-standing national objectives to varying degrees, it remains unclear how REDD+ can target main drivers of deforestation in the absence of a more politically engaged and nationally-owned planning process, that also questions the prevailing logic of avoiding these drivers. Stronger ownership could be developed via more mutually driven REDD+ planning, while tackling main drivers of deforestation necessitates as a starting point the engagement of powerful actors that have so far been absent from REDD+ debate.

Email: coler@u.nus.edu

Session B-09 (50): Sustaining management and utilization of bamboo and rattan resource

Development of bamboo bundle laminated veneer lumber (BLVL) double beams

Ge Wang
International Center for Bamboo and Rattan (ICBR)

Large span bamboo bundle laminated veneer lumbers (BLVLs) were prepared by combining the prepress densification process and the intermittent hot press process. A new type of BLVL double-beam members was developed and their bending properties including ultimate load, static bending strength and strain distribution were systematically analyzed by comparing with other double beams with different members. The results showed that large span BLVLs could be well prepared by intermittent hot press process and its mechanical properties could meet the requirements of 160-E superior products according to Chinese national standard GB/T 17657-2013. Besides, the values for the cross-section flexural rigidity and bending modulus of BLVL double beams were extremely high. Bamboo-wood composites (BWC) double beams with more ductility coefficient had a great ability of plastic deformation. For these double beams, the cross-section stiffness was the first factor which to be considered and optimized and the change of the strain along thickness direction was linear, which was in line with the hypothesis theory of bending plane of materials. This study was finally beneficial to design, manufacture, and application of bamboo-based structural engineering materials with lightweight, low cost, and excellent mechanical performances by supplying financial data support.
Email: wangge@icbr.ac.cn

Manufacture process and application of structural glued laminated bamboo

Liu Huanrong, Sun Zhengjun, Zhang Xiubiao
International center for bamboo and rattan

In order to efficient use of bamboo, this study is aim to manufacture engineering glued laminate bamboo and enlarge its application area. The properties and structure of bamboo was studied which provide the base data for grade criterion. Then 20 thousand strips were graded to nine grades from 0.45-0.9 g/cm^3 in 0.05 g/cm^3 interval density. According to the design rule of glulam, glued bamboo laminations were manufactured in butt end connection and in longitude continuous hot-pressing process. Then structural glued laminated bamboo were made of bamboo laminations base on AITC-117 Standard. The physical properties of structural Glued Laminated Bamboo were tested which met to the construction bean and bridge member demands. So they had been used in a construction building and a 12 meter-span bridge which were in Taiping Anhui province in Chongqing in China respectively. So, Bamboo, as a green and fast growing and environment friendly plant, is potential for structural engineering material in future.

Email: huanrongliu@126.com

Genome-wide analysis of shoot growth-associated alternative splicing in moso bamboo

Gao Jian
ICBR

Alternative splicing (AS) significantly enhances transcriptome complexity and is differentially regulated in a wide variety of physiological processes in plants, including shoot growth. Presently, the functional implications and conservation of AS occurrences are not well understood in the moso bamboo genome. To analyze the global changes in AS during moso bamboo shoot growth, fast-growing shoots collected at seven different heights and culms after leaf expansion were sequenced using the Illumina HiSeq™ 2000 sequencing platform. It was found that approximately 60.74 % of all genes were alternatively spliced, with intron retention (IR) being the most frequent AS event (27.43 %). Statistical analysis demonstrated that variations of AS frequency and AS types were significantly correlated with changes in gene features and gene transcriptional level. According to the phylogenetic analysis of isoform expression data and AS frequency, the bamboo shoot growth could be divided into four different growth periods, including winter bamboo shoot (S1), early growth period (S2–S5), late growth period (S6 and S7), and mature period (CK). In addition, our data also showed that the winter bamboo shoot had the highest number of AS events. Twenty-six putative Serine/arginine-rich (SR) proteins were identified, producing a total of 109 transcripts. AS events were frequently and specifically regulated by SR splicing factors throughout shoot growth, resulting in changes to the original open reading frame (ORF) and subsequently changes to conserved domains. The AS product-isoforms showed regular expression change during the whole shoot growth period, thus influencing shoot growth. All together, these data indicate that AS events are adjusted to different growth stages, providing briefness and efficient means of gene regulation. This study will provide a very useful clue for future functional analyses.

Email: gaojian@icbr.ac.cn

The standardization of bamboo construction and INBAR's role

Kewei Liu
International Network for Bamboo and Rattan

The standardization of bamboo construction is critical for the development of modern bamboo construction industry. Since the first two ISO standards of round pole bamboo (ISO22156 &ISO22157) have been published in 2004, many countries has taken ISO standards as their national standards. INBAR now is leading a research group to update and review existing ISO standards as well as developing new standards in the coming years. INBAR Construction Task Force, which will be one of those parallel task forces of INBAR Technical Advisory Committee to be established this year, plays an important role in bamboo construction standardization. Since its establishment in 2014, the INBAR Construction Task Force has successfully built an effective mechanism to develop international standards, disseminate bamboo building knowledge and support global coordination on sustainable bamboo construction.

Email: kwliu@inbar.int

Current trends in bamboo and rattan international markets and the case for standardisation

Oliver Frith
International Network for Bamboo and Rattan

The presentation will provide participant with information on current trends and developments in international trade in bamboo and rattan products, as well as give forecasts for future development of the market. This will also include an introduction to the new planned expansion of the current World Customs Organisation HS Codes for bamboo and rattan products from 16 to 24 codes, as well as latest international developments in the setting of standards to support global trade.

Email: obfrith@inbar.int

Effects of ramet ratio on water physiological integration in indocalamus decorus

Guo Ziwu[1], Hu Junjing[2,1], Chen shuanglin[1]
1. Research Institute of Subtropical Forestry, Chinese Academy of Forestry
2. Hangzhou Academy of Forestry

Physiological integration of clonal plants allows resources to transport and share between ramets and enhances adaptability to heterogeneous habitats. Furthermore, water physiological integration is an important part of physiological integration of clonal plants, analysis on characteristics of water physiological integration in bamboo has important significance for the scientific water management of bamboo forest. To provide theoretical guidance for artificial water supply and water saving management of bamboo forest, this study aims to explore the direction, intensity and ramet ratio effect of water physiological integration in bamboo. The experiment with connected *Indocalamus decorus* clonal ramets under different two matrix relative water content (high water potential (90% ± 5%) and low water potential(30% ± 5%)) and five ramet ratio (1:3, 1:2, 1:1, 2:1, 3:1, the ramets amount ratio of high water potential ramet to low water potential ramet, there are totally 12 strains of underground stem connected ramets) were conducted, and the antioxidant enzyme activity, content of soluble protein, malondialdehyde and photosynthetic pigment were determined. Water physiological integration existed inI. decorus clonal system under heterogeneous water environment, allowing water to transfer from high water potential ramets to low water potential ramets. With ramet ratio increasing, integration intensity was enhanced and the benefit of receptor ramet and consumption of donor ramet increased, too. Moreover, with treatment time extending, water integration intensity between connected clonal ramets increased in early time, but it weakened later, which reflected that the consumption-benefit effect of donor ramets and receptor ramets changed in time dimension, and the change was much more obvious in early stage of the treatment. The results indicated that ramet ratio of clonal system have a major impact on water physiological integration, water gradient between ramets is the potential driving force of water transport, the direction and intensity of physiological integration is ultimately determined by the status of water supply and demand in the intra-clonal system.

Email: hunt-panther@163.com

Influence of mulching management on the relationship between foliar non-structural carbohydrates and N, P in Phyllostachys violascens stand

Guo Ziwu, Chen shuanglin
Research Institute of Subtropical Forestry, Chinese Academy of Forestry

To approach the impact of intensive and mulching management on concentration and ratios of non-structural carbohydrates (NSC), nitrogen (N) and phosphorus (P) in bamboo foliage, and to clarify the adaptive mechanism of Phyllostachys violascens to mulching management, some indicators such as the concentration of NSC component, N and P elements in Ph. violascens foliage as well as its stoichiometry from bamboo stand with different mulching management years (6a,3a,1aand CK) were analyzed. The results showed in1astand concentration of NSC, soluble

sugar, N and P in foliage increased, and foliar starch and N:P ratios decreased markedly, N limitation to bamboo growth strengthened. While soluble sugar decreased significantly, starch increased dramatically in3astand. Though there was no difference on NSC concentration between3astand and CK, content of NSC by per unit of N and P increased significantly. However for foliar NSC, soluble sugar, N and P in6astand they decreased significantly, and foliar starch and N:P ratios increased dramatically, P limitation to bamboo growth strengthened under long-term mulching management (6 a). Moreover there was significant positive or very significant positive relationship between NSC, soluble sugar and N:P ratios, and very significant positive relationship between soluble sugar and N, P content. Besides, foliar NSC significantly positively correlated with N and P content in short-trem mulching management stand(≤3 a), and foliar starch content in CK and1 astand had positive relationship with N and P content, but showing negative relationship with N:P ratios. While foliar starch content in6astand significantly negatively correlated with N and P content, and very significantly positively correlated with N:P ratios. Based on all the results, it indicated that short-term mulching management accelerated the accumulation of foliar soluble sugar and decomposition of foliar starch, growth and activity of Ph. violascens enhanced greatly. And long-term mulching management promoted the accumulation of starch, and resulted in transition from N element limitation of bamboo growth to P element limitation. Accordingly, growth and activity of Ph. violascens decreased dramatically, and gave rise to bamboo stand degradation. Furthermore, foliar NSC, N and P concentration was higher with mulching term, and the utilization efficiency of N and P was highest among all bamboo stands which implied suited mulching management period was 3 years.

Email: hunt-panther@163.com

Session G-09 (71): Role of university and experimental forests in the long-term forest research and enhancing forest technology in East Asian region

Applying the stand-based silvicultural management system for close-to-nature forestry: 58 years of experience at the University of Tokyo Hokkaido Forest

Toshiaki Owari
The University of Tokyo Forests, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan

Close-to-nature forestry is a type of forestry, in which the intrinsic processes of forest ecosystems are regarded as highly important. Partial cutting with natural regeneration is typically used, so that the stability and diversity of stand structure can be maintained. It is increasingly gaining attention worldwide as an effective method for sustainable forest management and enables to harmonize the use of renewable natural resources with the conservation of multiple ecological functions. As a unique application of close-to-nature forestry in northern Japan, the stand-based silvicultural management system has been used since 1958 at the University of Tokyo Hokkaido Forest. Under the system, forests are periodically classified into several forest types according to stand characteristics and management objectives. For each type, an appropriate silvicultural treatment or a combination of treatments is determined in an adaptive manner. Single-tree selection harvest has been implemented as the main silvicultural system, in which trees are periodically selected and harvested individually from a large area. The system is currently using innovative spatial information technologies for silvicultural management planning. Both scientific and expert knowledge for close-to-nature forestry gained through nearly 60 years of experience as well as major management challenges are presented.

Email: owari@uf.a.u-tokyo.ac.jp

The long-term research on the selection of plantation species in the Seoul National University Forest, Korea

Pil Sun Park, Hyun Jung Kim, Jong Bin Jung, Linh Thuy My Nguyen, Daeho Choi
Seoul National University

Right tree in the right place is a key success factor in forest establishment. Each tree species has its own niche and growth characteristics, causing species distribution changes along environmental gradients. Tree lives longer than human and its growth and environmental demand change in each life stage, making difficult to clearly understand the whole ecology of the tree species within a generation of human population. Thus, long-term monitoring on target tree species is necessary to understand the species characteristics. University forest is an ideal place to conduct the long-term research such as investigating species ecology and to test the potential to be an economic species. Plantations of *Pinus koraiensis, P. thunbergii, Chamaecyparis obtusa, Chryptomeria japonica, Larix kaempferi, Quercus acutissima*, and *Quercus variabilis* were established in 1920s in the Seoul National University forest to test the performance of the species and to determine the potential to be a major plantation species. The plantations have been monitored since then. Each species showed different growth pattern. The site fertility affected the growth of the species. Majority of plots showed the senescence of trees 70–80 years after the stand establishment. The long-term data can be used to develop the silvicultural plan of plantations.

Email:pspark@snu.ac.kr

Altitudinal variation of growth traits and sap production of acer pictum var. mono populations at Baekun mountain in SNU forests, Korea

Yang-Gil Kim[1], Dae-Young Kim[1], Soon-Ho Kwon[1], Ji-Min Park[1], He-Jin Lee1, Kyu-Suk Kang[1,2]
1. Seoul National University
2. Research Institute of Agriculture and Life Sciences, SNU

We investigated altitudinal variation of growth traits and sap production of Acer pictum var. mono at Mt. Baekun area in Soule National University Forests located at Gurye-gun, Jeollanam-do, South Korea. Acer pictum var. mono is of great ecological and economic importance as it occupies unique territory in Korea. It is one of the major forest tree species in its habitat and produces good quality timber and edible sap. For the study, we have set 20m x 20m plots at 400m and 900m elevations, and measured growth traits (height, diameter at breast height), sap production, and dominance. Based on the surveyed characteristics, we are now analyzing the altitudinal genetic variation of Acer pictum var. mono populations. Growth of Acer pictum var. mono was superior at low elevation population compared to high altitude population. In each plot, Acer pictum var. mono was dominant species and the averages of DBH and height were 28.34cm and 13.2m at 400m elevation, and 18.72cm and 12.3m at 900m elevation, respectively. Sap production of Acer pictum var. mono had no correlation with altitude, but it was related to

geographic distance from water sources. Individual tree of Acer pictum var. mono that was close by water source showed higher sap production than that of far from water source.

Email: rladidrlf@naver.com

Permanent plots in Mount Makiling and Mt. Banahaw, Luzon, Philippines, an approach to address food security and climate change

Pastor, Jr. Malabrigo,Nelson Pampolina, Juancho Balatibat, Crusty Tinio, Cristino, Jr. Tiburan, Willie Abasolo, Arthur Glenn Umali, Amelita Luna, Jeferson Boncodin
College of Forestry and Natural Resources, University of the Philippines Los Baños

The establishment and maintenance of a network of permanent biodiversity monitoring areas in various forest ecosystems would not only provide a secured/protected landscape for a number of important organisms that has the potential to alleviate food security but would also create a field/laboratory and demonstration areas where quality hands-on learning experience for students and researches could be conducted. This study aims to contribute in addressing food security agenda in the Philippines through sustainable management and conservation of biodiversity resources from critical mountain ecosystems as affected by climate change. Standard two-hectare permanent monitoring plots were established each inside Mount Makiling (Laguna) and Mt. Banahaw (Quezon), Luzon, Philippines. Results of the completed inventory in Mount Makiling revealed significantly high diversity and endemism for all the major groups such as flora, fauna, and fungi. The 2-ha plot harbors a total of 155 tree species belonging to 103 genera and 55 families. For fauna, a total of 34 species of wildlife consisting of birds (21) reptiles (6), mammals (2) and forest frogs (4), were recorded. Thirty 37 genera of fungi with 51 species were documented from the 27 (10m x 10m) sampling plots. For potential food sources, out of the 155 tree species, at least 25 were found potential food sources. The fruit sample that has the biggest diameter and also the heaviest is Balukanag (*Chisocheton cumingianus subsp*. *cumingianus*). The study concluded that the biodiversity of Mount Makiling has great potential to alleviate food security but recommended further valuation of properties of potential food sources and their ecological dynamics as bio-indicators of climate change. To duplicate and develop networks of permanent plots, experts from the University of the Philippines, capacitated staff of Southern Luzon State University and Romblon State University for the establishment of their own permanent plots.

Email: plmalabrigo@up.edu.ph

Long-term monitoring and inventory data at the University of Tokyo Forests

Naoto Kamata
University of Tokyo

Under changing environments, long-term monitoring and inventory data are important to detect temporal changes in environments and ecosystems. The most general one is meteorological data obtained at Meteorological Agency in each country. However, observatory stations are normally located in urban area. On the other hand, university forests are normally located in remote areas so that climate data that have been obtained by university forests can complement the data obtained by the Meteorological Agency. The University of Tokyo Forests (UTF) consist of seven regional forests that are located in Hokkaido (UTHF), Chiba (UTCBF), Chichibu (UTCF), Tanashi

(UTTF), Fuji (FIRI), Izu (ARI), and Aichi (ERI). Increasingly violent typhoons and many more changes in our climate have recently attributed to global warming. Recent globalization has also caused catastrophic damage to UTF by introducing alien species. The UTF has accumulated long-term ecological and meteorological data that are available for our forest management and researches: LTER plots, other stand plots, meteorological and hydrological data, bird community, plant and vertebrate inventory, and others. We will introduce two fruitful outcomes that were obtained by analyzing these long-term data. One is a topic analyzing long-term hydrological data. It was found that, in association with the long-term natural recovery of forests on denuded hills, mean annual evapotranspiration for the late period of the recovery was 80 mm larger than that measured for the early period. The other is to determine long-term (> 100 years) changes in temperature at forested area by employing various kinds of corrections: instrumental error, difference in time of observation, and difference in the method to obtain mean temperature.

Email: kamatan@uf.a.u-tokyo.ac.jp

Progress and challenges from experimental forests in Korea

Dae-Young Kim[1], Soon-Ho Kwon[1], Ji-Min Park[1], Sung-Joon Na[2], Kyu-Suk Kang[1]
1. Seoul National University
2. National Institute of Forest Science

Korea had highly rich and productive forests before Japanese colonial ruling and the Korean War. During the Japanese occupation, a large area of forest was destroyed by over-cutting. In addition, the Korean War lasted for three years. After that, many people went to the forests and cut the trees without any permit from the authority. Thus, almost all mountains except remote areas were denuded. Forest Genetics Research Institute was established in 1956. First, the Institute has done much of hybrid breeding such as hybrid pines (*Pinus regitaeda*) and hybrid poplars (*Populus alba* x *P. glandulosa*). Second, introduction breeding has been done. During the Japanese occupation, which was the first phase of introduction, a total of 376 species was introduced from 30 foreign countries and tested adaptation ability at 388 different sites. In the second phase, 415 species from 38 countries were introduced again and eight species were selected and released. In the third phase (1996-present), continuous adaptation test and selection have been doing. Third, plus trees have been selected from wild forests since 1959 and used for establishing seed orchards. Lastly, special purpose tree breeding program has been doing and developed many new varieties of fruits. Recently, molecular breeding and genomics are being applied into conventional works. In my presentation, major achievement and prospect from experimental forests will be stated and discussed.

Email: dykim1988@snu.ac.kr

Temporal and spatial dynamics of canopy trees in and old-growth beech forest in Western Japan

Uyanga Ariya[1], Ken-ya Hamano[2], Takushi Makimoto[3], Shu Kinoshita[2], Yasuaki Akaji[2], Yuko Miyazaki[2], Muneto Hirobe[2], Keiji Sakamoto[2]
1. Forest Ecosystem Monitoring Laboratory, School of engineering and applied science, National University of Mongolia, 106 toot, Building-V, Bagatoiruu, Ulaanbaatar, Mongolia
2. Department of Environmental Ecology, Graduate School of Environmental and Life Science, Okayama University, 1-1-1 Tsushima-Naka, Okayama 700-8530, Japan

3. Okayama Prefecture Mimasaka General Service Bureau, 53, Sannge, Tsuyama-shi, Okayama 708-8506, Japan

The effect of disturbance on forest structure, tree regeneration and species diversity is essential for understanding forest dynamics. Here, we explore the dynamics of canopy trees in an old growth beech (Fagus crenata) forest with co-dominant species in the canopy layer based on relationship between establishment of canopy trees and disturbance history. Age-class distributions indicated F. crenata showed continuous establishment, but Magnolia obovata showed simultaneous establishment. Initial growth and spatial distribution patterns were differed between canopy trees of F. crenata and canopy trees of M. obovata. This study showed that the F. crenata canopy trees were mostly established in small gaps or under closed canopy with random distribution pattern in the research plot. Magnolia obovata canopy trees were established in large gap with aggregated distribution pattern in the research plot. Historical disturbance records near study plot are not always coinciding to estimated growth releases. Accordint to this research result, large disturbances did not occur over hundred years after establishment of M. obovata in this forest. Small gaps facilitate invasion and regeneration of F. crenata canopy trees. Magnolia obovata canopy trees originally established in large gap which is created by rare intensive disturbance.

Email: treering7@yahoo.com

Session H-9A (9): Towards a green economy in Asia: inserting forests into the sustainable development goals

Payments for forest ecosystem services in Asia: from ideas to practice

Pia Katila
Natural Resources Institute Finland

Payments for ecosystem services (PES) are seen as one tool in developing the green economy. PES can be defined as transfers of resources between social actors which aim at creating incentives to align individual and/or collective land use decisions in the management of natural resources with wider social interests. The number of PES-schemes has increased substantially during the past decade. The nature of these schemes varies widely, ranging from individual projects to national scale programs. They encompass both market-based payments involving the providers of ecosystems services (sellers) and the buyers of these services as well as governmental payment schemes. The forest-related schemes have mainly focused on carbon, biodiversity and hydrological services. This presentation gives an overview of the forest-related PES schemes in Asia, specially focusing on the different incentive mechanisms, their geographical scope and livelihood outcomes.

Email: pia.katila@luke.fi

Corporate commitments to sustainability: new discourses and praxis in oil palm production in Indonesia

Pablo Pacheco
CIFOR

This paper examines the scope of commitments to deforestation-free supply chains, in the context of shifting discourses on sustainability of palm oil production with focus on Indonesia. It comprises commitments made by companies along the palm oil global value chain from consumer goods companies and retailers to traders, processors and producers, and how do they synergize and contradict with government views on sustainability and expectations on zero legal deforestation. Furthermore, our analysis will examine the type of interventions planned and implemented by major palm oil corporate groups aimed at enhancing the governance of palm oil supply, as well as the main risks and opportunities emerging from interventions to ensure that deforestation-free supply chains are achieved. Main risks are associated with the likely exclusion of suppliers that do not comply with standards, and the likely expansion of production on non-forest lands which are often occupied by smallholders. Main opportunities relate to the possibility to upgrade the smallholders' production systems with associated benefits in intensification and increase of supply that is deforestation-free. Nonetheless, major challenges emerge in the need to harmonize private discourses and praxis with government regulations and approaches to ensure that sustainability is achieved without putting social inclusion on risk.

Email: p.pacheco@cgiar.or

Forests in the green development discourses and the need for ground thruthing

Wilhelmus De Jong
Kyoto University

The global discourses on forests, forestry, forest development and forest conservation have changed since forests became on global environmental agendas in the 1980s. The latest reiteration of forest discourses are much influenced by contemporary sustainable development discourses or environmental discourses, characterized by key words like green economy, green growth, low carbon development, or climate-smart agriculture. Multiple forest actors who gather around goals like sustainable forest management, tropical forest conservation, community forestry, forest devolution and indigenous forest rights have adopted and internalized the latest iteration of the global environmental discourses. In this presentation, which is an introduction to the session, I will provide an overview of how forest discourses have evolved since the 1980s, how sustainable development discourses have evolved, and how the forest discourse has adopted and internalized the latest sustainable development discourse. I will also provide some critical reflections on implications of the observed changes in sustainable development and forest discourses for policies, practice and academic analysis. Finally, I will gather some evidence for possibly implications in locations where usually forest development is considered an option or actually pursued.

Email: dejongwil@gmail.com

Are sustainable development goals and sustainable forest management converging in Asia? Synthesis and remaining questions

Glenn Galloway
University of Florida

This presentation will explore to what degree the newly adopted Sustainable Development Goals and Sustainable Forest Management are converging in Asia by drawing on the main findings of the preceding speakers related to this topic and other relevant sources. Convergence would imply that outcomes of the SDGs and SFM are aligned and complementary. Various pathways can lead to a convergence of the SDGs and SFM. For example, SFM could be shown to be contributing directly or indirectly to the SDGs through positive impacts on income, jobs, food security, status of forest resources, biodiversity, water, energy or even land tenure. For their part, SDGs could favor SFM through efforts to reduce inequality, mitigate climate change, conserve forests and biodiversity, and by promoting peaceful coexistence and good governance at different scales. The presentation will also reflect on what might lead to a lack of convergence between the SDGs and SFM and explore interactions among the SDGs that could lead to trade-offs that undermine the environmental and socioeconomic objectives of SFM. A summary of implications for practitioners and policy makers will finalize the presentation.

Email: ggalloway@latam.ufl.edu

From REDD+ performance to green promises: implications of joined discourses for policy implementation

Pham Thu Thuy Pham
Center for International Forestry Research

Reducing Emissions through avoiding deforestation and forest degradation (REDD+) is currently a major item in climate change negotiations. Transformational change of governance frameworks is crucial in overcoming the challenges in the design and implementation of REDD+. Simultaneously, green growth (GG) and green economy (GE) ideas have become dominant global narratives and often seen as synergistic with REDD+ in achieving major changes in economic, regulatory and governance frameworks. However, the exact relationship between REDD+ and GG remains vague. This paper examines how GG/GE and REDD+ have unfolded, and linked in Indonesia and Vietnam. It discusses the challenges for decision makers how to translate these narratives in terms of policies and outcomes. We take a comparative, mixed methods approach and analyze national policy documents as well as policy actors' perceptions and stances on enabling conditions for REDD+ and challenges of GG/GE based on surveys undertaken in 2011- 2015. We contrast these findings with the progress made in the implementation of REDD+ and GG/GE over time. Although both REDD+ and GG/GE explicitly state the need for transformational change, rhetoric dominates over policy action so far, and actors still perceive development and environmental objectives as a zero sum struggle, favouring and development narrative that might not lead to neither REDD nor green policy action.

Email: t.pham@cgiar.org

Session H-9B (63): woody and bamboo biomass management and utilization for bioenergy and bioproducts

On the application of mixture Weibull distribution to statistical analysis of fracture strength of LVL made from fast growing trees

Yukihiro Tamura, Koji Murata
Kyoto University

Fast growing trees are gathering much attention as a renewable resource and those trees are used for producing not only pulp but also more valuable products like plywood and laminated veneer lumber (LVL). However, veneer of those trees has many defects such as knots which affect the strength of plywood and LVL, so it is important to know statistical distribution of fracture strength of them. In this research, we prepared two kinds of LVL specimens made from fast growing poplar and eucalyptus grown in China using a phenol resin adhesive and carried out tensile shear tests. The specimens showed almost brittle failure. Therefore, single and mixture Weibull analyses were able to be applied. Single Weibull distribution was suitable for poplar LVL and mixture Weibull distribution was suitable for eucalyptus LVL. This was considered to be because there were many small knots in the surface of eucalyptus veneer, but no remarkable knots in that of poplar veneer. Wood failure ratio of LVL specimen was observed, but wood failure ratio did not relate to the kinds of defects estimated from single or mixture Weibull distribution. This result implies that widely used wood failure ratio is not useful when the brittle failure occurs.

Email: yuhi135781012tamu@gmail.com

Comparison of sulfite, sulfuric acid and sodium hydroxide pretreatments on bamboo shoots for enzymatic saccharification and ethanol fermentation

Li Zhiqiang, Jiang Zehui, Fei Benhua
International Centre for Bamboo and Rattan

The purpose of this research is to compare the certain pretreatments effect on bamboo shoots and mature bamboo for enzymatic saccharification. The relative mature bamboo results were presented in our former research. In this paper, the response and behavior of bamboo shoots to three pretreatments, sulfite (SPORL), dilute acid (DA), and alkali (NaOH), were investigated and compared with varied chemical loadings at 180°C for 30 min with a 6.25:1 (v/w) liquor-to-bamboo ratio. All the pretreatments improved the enzymatic digestibility of bamboo substrates. Under the investigated conditions, the cellulose to glucose yield of NaOH pretreated substrates was 100%, and the SPORL pretreatment achieved better enzymatic digestibility than DA pretreatment. The results suggested that the SPORL pretreatment be able to generate more readily digestible bamboo substrate with higher sugar yield and fewer fermentation inhibitors than the corresponding DA pretreatment. Almost all the glucose in hydrolyzates could be converted to ethanol after fermentation process. The highest ethanol yield could reach 95%. Bamboo shoots had higher sugar content and better enzymatic digestibility and therefore was a better feedstock for bioconversion than matured bamboo.

Email: lizq@icbr.ac.cn

Effects of coupling agent and thermoplastic type on interfacial bond strength between wood and thermoplastics

Qi Chusheng[1,2], Zhang Yang[1], Zhao Boshi[1], Zhou Miaomiao[1]
1. MOE Key Laboratory of Wooden Material Science and Application, Beijing Forestry University, Beijing 100083, China
2. Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing 100091, China

Thermoplastics as adhesives have an advantage of no formaldehyde emission during application compared with commercial thermosetting adhesives. However, coupling agent should be applied to improve the interfacial bond strength between hydrophilic wood and hydrophobic thermoplastics. Their interfacial bond strength was evaluated with the standard method of GB/T 9846 in this study, and the effects of coupling agents (MDI, KH550, QX201) and thermoplastic type (HDPE, LDPE, PVC, PP) on the interfacial bond strength were investigated. Beside, dynamic thermomechanical analyzer (DMA) was also employed to reveal their interfacial bond properties. The results show that the addition of coupling agent will increases the interfacial bond strength between wood and thermoplastics, and MDI is found to be the best coupling agent for all selected thermoplastics with a maximum bond strength of 2.0 MPa. PVC had the greatest bond strength with wood no matter with or without coupling agent compared with HDPE, LEDP and PP. Moisture had a great negative affect on the interfacial bond strength while KH 550 was used as coupling agent. Conversely, moisture had barely influence on interfacial bond strength while MDI was used to modify the wood surface. The results of MDA further prove that MDI are suitable for improving the interfacial bond strength of wood and thermoplastics.

Email: qichusheng@bjfu.edu.cn

Anatomical characteristics, microfibril angle and micromechanical properties of cottonwood (populus deltoides) and its hybrids

Wang Yurong[1,2], Liu Cangwei[1], Zhao Rongjun[1], Jessica McCord[2], Tim Rials[2], Wang Siqun[2]
1. Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing,100091, China
2. Center for Renewable Carbon, University of Tennessee, Knoxville, TN 37996, USA

This paper investigated the anatomical characteristics, microfibril angle (MFA) and micromechanical properties of cottonwood trees Populus deltoides (Pd) and its hybrids P. deltoides × P. maximowiczii (PdPm) and P. deltoides × P.trichocarpa (PdPt), which had been planted in Tennessee for two years. The results show， despite having the same male parent, Pd, PdPm and PdPt, had distinct performances in anatomy, MFA and micromechanics during their early developmental stage. The double-wall thickness of the fiber cells in the hybrid poplars were thicker than that of pure poplar, and there were not significant difference between the PdPm and PdPt. The PdPt with the slowest growth rate, also had the lowest MFA (11.5°), which may contributes to its greatest micromechanics value of hardness and reduced elastic modulus (0.31GPa and 12.18GPa) among the three kinds of poplars. The PdPm with the fastest growth rate had the largest MFA (16.7°) among the three kinds of poplars, however, it and Pd had similar micromechanics values. It could conclude that the hybrid way have improved some wood properties of poplar. This study provides new datas about juvenile wood properties with combined growth rate for Pd and its hybrids, PdPm and PdPt planting in Tennessee of the US.

Email: yurwang@caf.ac.cn

Novel thermosetting unsaturated ester polymers derived from tung oil

Liu Chengguo
Institute of Chemical Industry of Forest Products, Chinese Academy of Forestry

A novel unsaturated co-ester (co-UE) macromonomer containing both maleates and acrylates was synthesized from tung oil (TO) and its chemical structure was characterized by FT-IR, ^{1}H-NMR, ^{13}C-NMR, and gel permeation chromatography (GPC). The monomer was synthesized via a new synergetic modification of TO, by introducing maleic groups first and acrylic groups subsequently onto TO molecules. The influence of experimental factors on dynamic mechanical properties of the cured co-UE/styrene resins was evaluated to better understand structure–property relationships of the biomaterials and optimize experimental conditions. The obtained TO-based co-UE monomer possessed a highly polymerizable C=C functionality, consequently resulting in rigid bioplastics with high crosslink densities (ve) and excellent mechanical properties. For instance, the bioplastic prepared under the optimal synthesis conditions demonstrated a ve of 4.03×10^3 mol/m^3, storage modulus at 25°C of 2.40 GPa, glass transition temperature (Tg) of 127°C as well as tensile strength and modulus at 36.3 MPa and 1.70 GPa, respectively. The developed eco-friendly rigid biomaterials provide potential application in structural plastics such as molding compounds.

Email: lcg1512@163.com

Effect of thermal treatment on properties of eucalyptus wood

Cao Yongjian, Li Xingwei, Xie Guijun, Wang Jianjing, Hong xia
Guangdong Academy of Forestry

Thermal treatment has been known for a long time as one of the most effective methods to improve the dimensional stability, decay resistance and durability of wood. Eucalyptus wood is one of the most commonly planted tree species in China. As a fast-growing species, the main drawback is dimensional instability, which limits its utilization. In this study, three species of eucalyptus were thermal treated at temperature from 180℃ to 220℃ and length of time from 1 to 5 hours. The results indicated that the dimensional stability of wood was increased by 78% for anti-shrinkage and 65% for anti-swelling at 220℃ with 5 hours, respectively. The modulus of rupture (MOR) and modulus of elasticity (MOE) of wood was decreased by 66% and 22% respectively at the same treatment combination. The decay resistance of wood was also improved by thermal treatment due to the weight loss of treated wood was reached to 16%, compared to 56% of control sample .through thermal treatment Regarding color change, the chroma difference (ΔC*) decreased gradually, while the color difference (ΔE*) and hue difference (ΔH*) increased with an increase in temperature and length of time. An analysis of variance (ANOVA) revealed that the treatment temperature plays a more important role in modifying wood properties during the process of thermal treatment in comparison with the treatment time.

Email: yjcao@sinogaf.cn

Investigating gaseous carbon, nitrogen and sulfur compounds of bamboo, wood and coal during pyrolysis process

Liu Zhijia, Hu Wanhe, Mi Bingbing, Jiang Zehui, Fei Benhua
International center for bamboo and rattan

In this study, bamboo, wood and coal were pyrolyzed by thermogravimetric analyzer coupled with fourier transform infrared (TG-FTIR) to investigate gaseous carbon, nitrogen and sulfur compounds of fuels during pyrolysis process. It was found that the main gas compounds of fuels included carbon dioxide, carbon monoxide, methane, sulfur dioxide, hydrogen sulfide, ammonia gas and hydrogen cyanide. Bamboo and masson pine respectively had a higher gas releases at low and high pyrolysis temperature zone. During the whole pyrolysis process, coal had the lowest gas releases. This phenomenon was mainly due to different pyrolysis characteristics of fuels. Bamboo had lower pyrolysis temperatures and more mass losses at the low pyrolysis temperature zone, compared to masson pine. Coal had the highest pyrolysis temperature and the lest mass losses. The char-C, N and S contents of all fuels increased with increase in pyrolysis temperature, except for char-N of coal. The results from this research will be helpful to develop and utilize the wastes of masson pine and bamboo for energy products and efficiently design and operate its combustion systems.

Email: 472491002@qq.com

Session H-9D (106): Emerging ecofriendly wood protection strategies for plantation-grown wood for a greener society

Effects of cell wall modification on the degradation of wood by fenton reagent

Xie Yanjun[1], Xiao Zefang[1],CarstenMai[2]
1. Northeast Forestry University
2. Georg-August-University Goettingen

The Fenton reaction is supposed to play a key role in the initial wood degradation by brown rot fungi.Wood veneers were esterified and etherified by treatment with 1,3-dimethylol-4,5-dihydroxyethyleneurea (DMDHEU) and glutaraldehyde (GA) to various weight percentage gains and the modifying effects on the degradation behavior of wood by Fenton reagent were determined. Veneers modified with higher concentrations (1.2 and 2.0 mol l-1) of both chemicals exhibited minor losses in mass and tensile strength during treatment with Fenton reagent, which shows restrained oxidative degradation by hydroxyl radicals. The decomposition rate of H_2O_2 was lower in the Fenton solutions containing modified veneers than in those containing unmodified controls. More CO_2 evolved in systems containing unmodified veneers than in systems with modified veneers, indicating that modification protected wood from mineralisation. The reason for the enhanced resistance of modified wood to the Fenton reaction is attributed to impeded diffusion of the reagent into the cell wall rather than to inhibition of the Fenton reaction itself. The results show that wood modification with DMDHEU and GA is able to restrain the degradation of wood by the Fenton reaction and can explain why modified wood is more resistant to brown rot decay.

Email: xieyanjuncn@hotmail.com

Preparation and applications of wood preservatives from copper and boron salts combined with feather protein

Xia Yan
1. Beijing Forestry University
2. South-West Forestry University

Due to the remarkable biological properties, wood preservatives formulated with cooper, boron, and protein (plant or animal protein) have been proposed as substitutes for the high-cost copper azole (CuAz) and alkaline copper quaternary (ACQ). In this study, feather was used as the source of protein and combined with copper and boron salts to prepare wood preservatives. The treatability, leach ability, field decay resistance, Fourier transform infrared spectroscopy (FT-IR) and X-ray diffraction (XRD) characteristics of the obtained wood preservatives were investigated in detail. Results showed that the treatability of Cu and B were 94% and 96%, respectively, closed to their target retentions. The leach ability of copper-boron-feather protein was a little higher than that of the soy protein-based wood preservatives. FT-IR analysis confirmed the reactions of cellulose, hemicelluloses and lignin with copper-boron-feather protein wood preservatives. XRD patterns showed that the intensity of the peaks were decreased after the wood was impregnated with feather protein-based wood preservatives, indicating the interactions between wood components and preservatives. Moreover, the field decay experiments illustrated that the weight loss of the ground-contact wood samples decreased from 33.97% to 8.44% after being treated with the feather protein-based wood preservatives at the molar ratio of 2:1 (Cu:B) with the target retention of 8 Kg/m^3. Therefore, the feather protein-based wood preservatives could effectively prevent the wood products from ground-contact well, and be potentially used as environmentally friendly wood preservatives.

Email: 630509034@qq.com

Unravelling the mechanism involved in the degradation of 4,5-dichloro-2-octyl-2H-isothiazol-3-one (DCOIT) by Gloeophyllum trabeum.

Xue Jing, Zhu Yuan, Cao Jinzhen
Beijing Forestry University

Totally organic biocides system has currently played an increasing role in protecting woody materials from decay fungi because of the high efficacy and the benefits environment as opposed to metal-based wood preservatives. However, these organic biocides are more likely to undergo the degradation when being exposed to wood rot fungi, therefore challenging the application of organic biocides in wood preservation.This paper focuses on the mechanism for the biodegradation of organic wood preservatives. DCOIT, as the widely used organic biocides, was used to treat the sapwood of masson pine (*Pinus massoniana*), which was then exposed to G. trabeum. To mimic brown-rot fungal attack, meanwhile, a chelator-mediated Fenton (CMF) system was employed to decompose DCOIT under conditions naturally occurred within decayed wood. A rapid depletion of DCOIT was observed under G. trabeum treatment, specifically within the first two weeks. We therefore speculate that the decomposition of DCOIT was associated to some degrading agents in early stages of G. trabeum decay. Moreover, typical of the attacking pattern employed brown-rot fungi, a CMF system was found to decompose DCOIT effectively. With all data pulled together, we proposed that the CMF chemistry is the most likely agent to decompose DCOIT along with G. trabeum attack.

Email: lovemyselfforeverx@163.com

Performance of some protection chemicals in combination with thermal treatment on Scots pine

Shen Haiying, Cao Jinzhen
Beijing Forestry University

In this study, thermally-modified Scots pine (*Pinus sylvestris*) wood samples were further treated with colorant or combinations of colorant (C), water repellent (paraffin wax emulsion, PWE), and an organic preservative (4,5-dichloro-2-octyl-2H-isothiazol-3-one, DCOIT) micro emulsion. The temperature used in thermal modification is 140℃. Some physical and mechanical properties, anti-weathering performance in both accelerated lab-scale weathering test and outdoor weathering test were evaluated. The results showed that: (1) the treating groups with water repellent showed obvious lower water absorption, and the lowest water absorption appeared in the group treated with the combination of colorant, water repellent, and the preservative (C-PWE-DCOIT); (2) thermal modification improved the dimensional stability, while all the further treatments showed slightly negative effect on dimensional stability after 960h water soaking; (3) the modulus of rupture (MOR) of thermally-modified Scots pine showed little change after further treatments; (4) thermally-modified wood further treated with C-PWE-DCOIT showed the best anti-weathering performance by showing the least color change and the least occurrence of mold.

Email: shen_haiying@bjfu.edu.cn

Thermogravimetric analysis of glycerol-impregnated poplar wood power

Yan Li[1], Liu Rui[1], Chen Zhangjing[2]
1. Northwest A&F University
2. Northwest A&F University

In this study, the poplar (*Populus tomentosa*) wood powder samples (40 to 60 mesh) were impregnated with glycerol of five concentrations, 20%, 40%, 60%, 80%, 100%. Their thermal behaviors including mass loss (ML), duration of thermal degradation reaction (Drec) and maximum reaction velocity of thermal degradation (Vmax) were examined with thermogravimetric analysis at conditioning temperatures of 160,180, 200℃ and holding time of 90 minutes. The glycerol-impregnated poplar wood powder exhibited larger thermal degradation at the temperatures of 160,180, 200℃.After tests, the average residue was about 31.92% of original weight compared with non-impregnated poplar wood powder that had residue of 94.40% original weight, The thermal mass loss of impregnated poplar wood increased with glycerol concentrations and could reach 72.31% when the samples were impregnated with 100% glycerol at the conditioning temperature of 200℃. The Drec of glycerol-impregnated poplar wood decreased with the conditioning temperature. At 200℃, the Vmax of the impregnated wood decreased with the glycerol concentrations. While at the lower temperatures, such as 160 and 180℃ there is no statistically significant correlation between Vmax and the glycerol concentration. The largest Vmax was 8.41%/min for samples impregnated with 80% concentration glycerol at the temperature of 180℃.The glycerol impregnated poplar has higher thermal degradation rate than non-impregnated powder.

Email: liliyan@nwsuaf.edu.cn

Decay resistance improvement of *Firmiana simplex* and *Cunninghamia lanceolata* by metal bath heat treatment

KufreOkon
Fujian Agriculture and Forestry University

This study was carried out to evaluate the effects of the heat treatment at 150℃, 180℃ and 210℃ for 2h,4h and 8h on the resistance of *Firmiana simplex* and *Cunninghamia lanceolata* wood against fungal attack. The decay resistance of heat treated wood specimens were examined by laboratory decay resistance test, and specimens were exposed to wood degrading fungi *Poria placenta* and *Coriolus versicolor* for twelve weeks and mass loss was assessed. The results showed that the decay resistance of both wood against fungal attacked was improved with heat treatment. Decay resistance of *C. lanceolata* against both wood rot fungi was improved from durable to very durable with the highest resistant recorded at 210℃ for 8h. The scanning electron micrographs results indicated that wood specimens of metal bath heat treatment presented strong resistance against decay fungal attack.

Email: Kufreokon@uniuyo.edu.ng

Comparion of dynamic sorption and hygroexpansion of wood by different cyclic hygrothermal changing effects

Yang Tiantian, Ma Erni
Beijing Forestry University

This paper investigated the dynamic sorption and hygroexpansion of wood by different cyclic hygrothermal changing effects, poplar (populous euramericana Cv.) specimens, 20mm in radial (R) and tangential (T) directions with thicknesses of 4 and 10mm, were subjected to three environmental conditions, in the course of which relative humidity(RH) changed sinusoidally between 75-45% at 20℃ (condition A), or temperature changed sinusoidally between 5-35℃ at 60%RH (condition B) or both RH and temperature changed sinusoidally at 75-45% and 5-35℃ (condition C). Moisture content (MC) and dimensional responses were measured, gave the following results: Moisture and dimensional changes were generally sinusoidal. The observed equivalent RH and temperature changes at different △MCs or △Ts served for comparison of responses to RH and temperature, while the former were less pronounced than the latter. MC and T dimensional changes per unit change of RH were greater than those per unit change of temperature. Less time was needed to reach a given △MC or △T by condition C followed by A and B. These indicated the effects of dynamic RH change were stronger than temperature and treatment where both RH and temperature changed sinusoidally was most efficient to control MC and deformation in wood processing and application.、

Email: bjfu100514327@163.com

Water absorption and mold susceptibility of wood flour/polypropylene composites modified with silane-wax emulsions

Chen Yu[1], Cao Jinzhen[1], Liu Ru[2]
1. Beijing Forestry University
2. Chinese Academy of Forestry

Wood plastic composites (WPCs) can absorb water in exterior applications due to the hydroscopicity of wood flour (WF). The cycle of adsorption and desorption process causes damage to the interfacial bonding between WF and polymer matrix, which results in fungal attack. In this study, WF was respectively immersed with silane, wax emulsion, and their compound systems for modification at different concentrations (1%, 2%, and 4%, respectively). Then, the modified WF was mixed with polypropylene (PP) to produce WF/PP composites at mass ratio of 6:4. The water absorption and mold susceptibility of the composites against Aspergillus niger were investigated. The results showed that the water uptake of WF/PP composites treated with 4% silane decreased by 6% compared with the control and the average mold growth rating decreased from 4 (mold covering of 75-100%) to 1 (mold covering of 0-25%). The strong hydrophobicity of wax had a negative effect on the interfacial adhesion of the composites. Thus, composites modified with wax and silane-wax compounds showed higher water uptake than the control. However, the mold resistance of composites was also improved in these groups.

Email: chenyu0625@bjfu.edu.cn

Micro-nano Chinese herbal medicine wood preservative preparation and antifungal performance study

Wang Jie, Wang Yamei
Inner Mongolia Agricultural University

In this paper, Using Chinese herbal medicine-coptis as raw materials, micro-nano wood preservative which was non-toxic and efficient was prepared by dry ball milling. making the application of nano technology in wood protection field. The effect of ball grinding time, ball grinding speed, number of balls on the preparation of micro-nano copits was researched by Orthogonal test. By antibacterial comparative test measuring dry weight of hypha to determine the optimal preparation conditions. The test results showed that 8g of common powdery coptis were dry grinding by the frequency conversion planetary experimental grinding machine. Rhizome coptis which was ground has more obvious bacteriostatic effect than ordinary coptis, and the minimum mycelial dry weight of micro-nano Chinese herbal medical wood preservative is 0.007g, which was prepared under the condition of ball mill speed 280 r/min, ball grinding time 4h, ball number 60; the minimum inhibitory concentration is 0.1mg/ml; SEM showed that the main morphology of micro-nano copits was irregular sphere, the size of width or length size were in the middle of 200nm and 700nm. This fit the result measured by laser particle size analyzer.

Email: 1374499566@qq.com

Development of research on application of buried wood

Zhang Zhenxin, Wang Yamei
Inner Mongolia Agricultural University

With the gradual improvement of peoples environmentally friendly consciousness, the selection of antiseptic wood is prone to be green and healthy via the tradition of chemical preservative treatments to physical preservative treatments. The buried wood considered as a rare species in the field of antiseptic wood possesses more actual utilization value and aesthetic value. The buried wood is formed with ancient forests being buried in river or mud which was caused by earthquakes, floods, landslides and other natural disasters. The buried wood is slowly Carbonized under an anaerobic and high pressure condition with the interaction of microbial after thousands of years. This paper mainly analyzes the distribution and formation of buried wood, expounds the difference between buried wood and ebony, carbonized wood. The review includes species identification, physical structure and aesthetic value of buried wood, the chemical composition of essential oil and corrosion mechanism. Based on the view of forming environment for buried wood, finally, prospects about the developing direction of buried wood are described to propose the idea of technology that the fast-growing wood resources are transformed into the wood shares similar properties to buried wood, which provides a new way for eco-friendly antiseptic wood.

Email: z_zhenxin@163.com

Metal corrosion of Copper Azole (CA-C) / paraffin wax emulsion compound system treated wood

Wang Jiamin, Ma Erni, Cao Jinzhen
Beijing Forestry University

CA as a new generation of environmentally friendly water-borne wood preservative, its treated wood tends to accelerate the corrosion process of mental. To provide technical basis for reducing metal corrosion issue in wood preservation， the effect of adding paraffin wax emulsion into CA preservative on the metal corrosion of treated wood was investigated. In this work, two concentrations of CA (0.3% and 0.5%) were combined with three concentrations of paraffin wax emulsion (0.5%, 1% and 2%) to treat sapwood of *Pinus spp*. at the size of 19mm(T) ×38mm(R) ×89mm(L), using a full-cell process. Wood percent gain (WPG) and retention of copper in treated wood were measured and metal corrosion for stainless steel, hot dip galvanized steel and Q235A steel contacted with CA /paraffin wax emulsion compound system treated wood were tested according to the American Wood Protection Association Standard AWPA E12-08. Finally, it is concluded that adding paraffin wax emulsion to CA preservative could inhibit the corrosion of Q235A steel and hot dip galvanized steel contacted with the preservative treated wood, and as the concentration of paraffin wax emulsion increased, the rate of metal corrosion decreased.

Email: wangjiamin2013@hotmail.com

Synthesis and properties of POSS-containing bio-based non-isocyanate polyurethanes

Liu Guifeng[1], Wu Guomin[1,2], Chen Jian[1], Huo Shuping[1], Jin Can[1], Kong Zhenwu[1,2]
1. Institute of Chemical Industry of Forest Products, Chinese Academy of Forestry
2. Research Institute of New Technology, Chinese Academy of Forestry

As a new kind of environment-friendly polyurethane material, bio-based no isocyanate polyurethanes (NIPUs) have excellent properties, such as biodegradable, good environment compatibility, the process of preparation and utilization safely and so on. However, the NIPUs have a disadvantage in that the materials exhibit poor water resistance due to the presence of the hydrophilic primary and secondary hydroxyl groups in the main chain. Recently, for the purpose of improving the properties of NIPUs, several modifications have been exploited.

Polyhedral oligomeric silsesquioxanes (POSS) have attracted considerable attention because of their novelty and consequent potential applications. It has been demonstrated that the

modification of polymers with POSS could significantly improve the properties of materials, such as mechanical properties, thermal stability, water tolerance and fire resistance.

Therefore, to pursue the aim of developing novel bio-based NIPUs with perfect performance, bio-based NIPUs synthesized from renewable resources such as rosin and gallic acid, were modified with functionalized POSS to yield NIPU/POSSs, respectively. The properties of the NIPU and NIPU/POSS coatings were determined, and the influences of POSS on mechanical and thermal properties of the NIPU/POSSs were investigated. The results showed that by introducing POSS into the NIPU networks, the water tolerance, pencil hardness and thermal stabilities of the NIPU/POSS coatings were improved obviously.

Email: gfliunj@163.com

How serious is the environmental impact of high retention CCA treated hardwoods after 30years ground-contact in the Sarawak humid tropics?

Andrew Han HoyWong[1], Willy S.M.Chin[1]
1. University Malaysia Sarawak
2. Sarawak Forestry Corporation

Chromatid copper arsenate (CCA)-treated Malaysian hardwoods have long been used as utility poles, posts, construction piles and motorway fencing in soil contact exposed to the threats of decay fungi and termites. Despite global concerns citing predominantly temperate and sub-tropical conditions of long-term leaching of CCA toxic heavy metals from wood into surrounding soils and groundwater since the 1990's, the preservative leaching severity in the humid tropics has been far less appreciated due to dearth of work in this area. In 2013 (after 30years exposure), levels of total copper, chromium and arsenic within 20 exceedingly high CCA retention treated hardwood poles of Sarawak and in soils surrounding these poles, installed in 1980 and 1981 at a plot located in Timber Research and Technical Training Centre, Kuching, Sarawak, Malaysia, were sampled. The ground is waterlogged after heavy rainfall. It is shown that there is insignificant variations of CCA salt retention in wood between 1300 cm above ground and 0-20 cm below ground ($P<0.05$). Nevertheless, levels of these elements are significantly ($P<0.05$) elevated in soils surrounding, especially up to 25 mm away from, the poles than at distant sampling points (150 – 300 mm) from poles as well as at sites well away from the poles containing very low levels (<6 – 13.4 ppm) of such heavy metals. Metal levels were also highest at the soil surface directly in contact with the poles (0 – 50 mm soil depth position) and decreased with remaining 2 soil depth positions 150 – 200 mm and 300 – 350 mm. Mean extractable arsenic levels ranged from 14.5 to 100.1 ppm, chromium levels from 23.3 to 148.3 ppm and copper from 21.8 to 104.7 ppm. Results, indicating relatively higher CCA leaching from the Sarawak experience also concurred with trends reported for temperate and sub-tropical experiences and showed that soil closest to the treated poles are most contaminated after 30 years of in-ground exposure.

Email: awong.unimas@gmail.com

Biological durability performance of the longest glulam bridge in Malaysia after 18 years exposure and potential Sarawak timber species for fabrication of outdoor above ground glulam structures

Wang ChoonLing[1], Andrew H.H.Wong[2], J.K.Lai[3], K.B.Ting[3]
1. Forest Department Sarawak
2. University Malaysia Sarawak
3. Sarawak Forestry Corporation

A glulam bridge was fabricated in Timber Research and Technical Training Centre (TRTTC), by using selected and graded commercial sawn Alan (Shorea albida) heartwood timbers obtained from timber yards in Kuching. The sawn timbers were kiln dried and planned to standard thickness to form a beam of 36 meters with cross section of 130 mm width and depth of 720 mm from 42 piles were glued together using phenol formaldehyde. The bridge was commissioned on 18 March 1998 and was thus exposed to the Sarawak humid tropical weather since installation and the surfaces partly protected from Ultra violet ray by a layer of ICI coating and by a layer of solid wood plank walk on top of the glulam bridge, so the only factor affecting degrade of the glulam is decay. After 18years exposure, only the top surfaces first few plies (exposed to weather/sun) up to 5 cm depth as well as both secured ends of the glulam framework lengths were found to have delamination with minor decay. The secured ends degraded due most likely to water accumulation in the drill holes bearing nuts-and-bolts meant for anchoring both ends of the glulam framework to the concrete blocks for supporting the bridge. Despite an in-ground durability test data from Sibu, located 300 km from Kuching, showing that Alan heartwood has a mean in-ground service life of 18 months (both decay and termite hazard included), Alan heartwood as above-ground bridge glulam structures in Kuching performed remarkably well in this case against decay due perhaps to less likelihood for the structure to retain sufficient wood moisture that would have otherwise induced widespread decay while concrete probably deterred termites from the glulam members. Through the concept of timber design (ie. wood protection by design) it suggests that other heartwoods of Sarawak Timber species with at least the same natural durability class and also gluability as Alan could be also used as potential species for similar glulam bridge structures. A further recommendation for such wood bridge protection concerns the use of wood treatment based on observations of excellent performance of an aboveground CCA-treated refractory Acacia mangium heartwood glulam bridge located in TRTTC for the last 3 years showing no delamination and biological degrade. Supplementary recommended treatments could include also both physical and chemical soil barriers at both ends of the bridge closest to the ground where the glulam beam structures are erected in concrete.

Email: wangchoon@gmail.com

Session I-09 (59): Social responsibility for forestry corporates

Corporate social responsibility reporting by forest companies: the study of forest-based industry in China

Li Jia
College of Economics and Management of Nanjing Forest University

While the growing public interest in and global consciousness of environmental and social issues, the forest-based industry as a environmentally sensitive sector draw critical attentions in their sustainability activities and disclosure, in particular with the ongoing globalization of forest

industry and conflicting stakeholder pressure. Through analyzing the annual corporate social responsibility(CSR) policies and report in Chinese forest industry, this study identified the current corporate responsibility reporting(CSR) level of forest-based industry, and examined the report contents of important forest companies, to provide a better understanding of the sustainable disclosure of forest-based industry in China. Although the number and percentage of forest-based companies are increased gradually, the content of most CSR reports are still quite simple and not complete. While some companies are passive and only provided environmental information requested by regulations, other companies with an active environmental policy communicated about their overall eco-friendliness. Although the impact on ecosystem services is recognized academically, the reporting of ecosystem service in CSR report are still quite rare. Moreover, the results also reveal a wide variation in the amount and format of CSR reports. Finally, some policy recommendations are suggested to enhance the CSR activity and reporting incentives.

Email: lijiashy@hotmail.com

Forest ecosystem services, corporate sustainability and local livelihoods in industrial plantations of China: building conceptual awareness on the interlinkages

Anne Toppinen[1], Dalia DAmato[1], Katja Lähtinen[1], Mika Rekola[1], Wan Minli[1], Cai Dinglin[1], Wen Zuomin[2]
1. University of Helsinki
2. Nanjing Forestry University

The concept of ecosystem services is emerging within the global environmental and development discourses as a contemporary leading narrative, together with related strategies, agendas, tools and practices. In addition to its role in public policy, this concept has implications for the private sector as well. Little knowledge exists, however, on the linkages between the private sector and ecosystem services, especially from the viewpoint of company stakeholder groups and/or ecosystem services beneficiaries. In this paper, we compared managers', experts' and village leaders' perceptions of plantation forestry in China. We observed more similarities between the opinions of managers and village leaders than those of managers and experts (i.e., policy advisors, local authorities, industry associations and consultants and non-governmental organizations). This could mean that managers and village leaders who, sharing local contextual knowledge, have more common ground than, for instance, managers and experts who share similar technical expertise. The overall observed differences in stakeholders' perceptions open up possibilities to discuss the potential and limits of the ecosystem services narrative in legitimizing corporate sustainability strategy, and in deepening corporate sustainability agendas and practices in the context of an emerging country such as China.

Email: anne.toppinen@helsinki.fi

BINHI: public-private partnership in forest conservation in the Philippines

Pastor Jr. Malabrigo[1], Roniño Gibe[2], Ernesto Jr. De Guzman[2]
1. Department of Forest Biological Sciences, College of Forestry and Natural Resources, University of the Philippines Los Baños
2. Energy Development Corporation

The Philippines is one of the 17 mega-diverse countries in the world and considered the most important country for conserving diversity of life on earth. Philippine plants, of which more than half are found nowhere else in the planet, represent 5% of the world's flora. Regrettably, Philippine biodiversity are also the most threatened in the world being the 2nd biodiversity hottest spot and the 4th most endangered forest ecosystems with only 7% of the original forest cover remaining. Understanding the lack of capacity of the government to sustain a huge task of forest protection and biodiversity conservation, the Energy Development Corporation (EDC) initiated a noble corporate social responsibility program called BINHI (Filipino term for seedling). BINHI is the country's first comprehensive private sector-led restoration program that focuses on biodiversity conservation, carbon sequestration, socio- economic development, and ecotourism. BINHI has four modules, capturing the essential role of trees in our lives: Tree for Food (partnerships with forest communities in the establishment of plantations and agroforestry farms); Tree for Life (bridging forest gaps within important mountain systems using indigenous species); Tree for Leisure (development of EDC's geothermal project sites as viable ecotourism destinations); and Tree for the Future (securing and rescuing some of the rarest and most threatened Philippine trees). Acknowledging that forest conservation is a battle that can't be won if it is fought alone, EDC partnered with schools, private and non-government organizations, academics, artists, and government agencies. This paper will highlight the remarkable accomplishments, lessons, and inspirations acquired from BINHI's 8-year experience, from creating awareness for the youngsters through an annual youth conference, to developing partnerships and protocols for the propagation and conservation of the country's vanishing trees.

Email: plmalabrigo@up.edu.ph

Key stakeholders identification of forest companies based on Mitchell's three-attribute evaluation method

Xie Yu, Wen Zuomin
Nanjing Forestry University

Clearly identification of key stakeholders is the precondition for companies to develop a right corporate social responsibility strategy and obtain the competitive advantages. After a literature review and pre-investigation of forest companies, a questionnaire for stakeholder identification was designed base on Mitchell's three-attribute evaluation method, distributed to four case companies and 31 respondents were collected. Besides the questionnaire, we also collected the qualitative data by semi-structural interviews and group meetings with case companies and their stakeholders. Based the quantitative analysis of questionnaire and combined with qualitative analysis, stakeholder identification and comparison were conducted in this paper. This paper concluded that: (1) key stakeholders of case companies listed as employee, shareholder, consumer/customer, contractor, supplier, local community, local government, forest owner, NGO and local forest administration. These key stakeholders are all closely related with the core operations of case companies; (2) different companies vary on stakeholder identification, multinational companies have more key stakeholders than domestic; (3) key stakeholders of companies are not stable, policy, economic condition and technology can possibly affect the identification of stakeholders.

Email: xieyumse@qq.com

Estimating forest ecosystem service function of water conservation based on TVDI

Chen Shulin
Nanjing Forestry University

Eucalyptus is becoming the most important tree species in Guangxi province. However, the ecological Degradation caused by Eucalyptus have deeply threaten the stability and diversity of forest ecosystem. A better understanding of the forest ecosystem service function of water conservation for Eucalyptus is urgently required. In order to overcome the problem of spatial scales in estimation of forest ecosystem service function of water conservation, the technology of remote sensing was introduced to estimate the forest ecosystem service function of water conservation. The model of TVDI is used to estimate the forest ecosystem service function of water conservation in Stora Enso's raw material forest base. 157 observation points of in situ soil moisture measurements were selected to validate the effectiveness of the TVDI as an index for assessing soil moisture, and the results showed that there is a strong and significant negative correlation between the TVDI and the in situ measured soil moisture. This means that the TVDI is suitable for soil moisture estimation. This paper also calculated the value of the forest ecosystem service function of water conservation in Stora Enso's raw material forest base, and found that the sort of the value of the forest ecosystem service function of water conservation under the three tree species is: Mason pine > Eucalyptus > Chinese fir.

Email: chenshulin0923@163.com

Assessing social performance in state-owned forest farms in China: integrating forest social values and corporate social responsibility approaches.

Xu Danyun[1], Wang Lei[1,2], Liu Junchang[1]
1. Beijing University of forestry
2. Zhejiang agriculture & forestry university

Our study focuses on social performance of state-owned forest farms and proposes a framework, that evaluates to both resource and corporate-based approaches. We found that: 1) The overall average social performance score for the sample state-owned farms (3504 farms) assessed by our framework is 41.56 (out of 100 points), which implies that the social performance of Chinese state-owned farms was relatively low. 2) More developed provinces, score higher than less developed ones, which shows a regional difference of social performance in sustainable forest management(SFM). The clear implication here is that state-owned farms in less developed regions to improve their social performance, and put more effort into improving forest and ecological culture development, science and education, employment, stakeholder participation, and forest services etc. 3) The state-owned forest farms have developed a more balanced use of forest resources. The results suggest that social performance must therefore receive attention from managers and decision-makers in the long-term, and they have to adopt it as a corporate management tool. In general, our study suggests a practical framework for conducting management decisions and policymaking in social performance in SFM.

Email: xudanyun121212@126.com

Analysis on the stakeholders of the FDI forestry enterprises in China based on the view of social responsibility

Jia Weiguo
Nanjing Forestry University

Owing to the particularity of the forestry, the social responsibilities and social responsibility reports of the forestry enterprises are more important. Based on the view of social responsibility, forestry enterprises' stakeholders are identified from the perspective of enterprise dimension, supply demand dimension, spatial dimension and value dimension in this paper, based on two examples of FDI Forestry Enterprises in China. Furthermore, the correlations between the stakeholders and FDI Forestry Enterprises also be evaluated by these four dimensions, which lays the foundation for ascertaining the contradictions when these enterprises carrying out their responsibilities and stipulating the contents of the responsibility reports.

Email: 108998978@qq.com

Session F-09: China forestry policy

Conversion of cropland to forestry program: policy progress and links of ecological and economic impacts-evidence from 15 years CCFP households' observation

Chen Xie[1]; Kun Zhang[1]; Jianan Wang[1]; Jiang,Wang[1], Conghe Song[2], Louis Putzel[3]
1. China National forestry economics and development research center (FEDRC), SFA;
2. Department of Geography, University of North Carolina at Chapel Hill
3. Center for International Forestry Research (CIFOR)

China has launched the Conversion of Cropland to Forest Program (CCFP), also known as "Grain-for-Green," in the late 1990s when the catastrophic flooding and drought hit China. With 32 million farm families participated and reallocation and planting of trees over 25 million hectares in hilly and mountainous landscapes, CCFP has contributed both ecosystem remediation and poverty alleviation after 15 years implementation. In 2014, the new round of CCFP have been initiated aiming at converting 2.83 million ha of sloping cropland to forest in 2020.

What's the impact of this tremendous land-use change to rural livelihood? Will ecological improvement eventually extend farmer's production-possibility frontier and forest ecological restoration become farmer's autonomy? The answer of those questions will not only address the hypothesis of 'rural poor has the autonomy to protect environment as they are more rely on it', but also helps to identify farmers who willing to participate new round of CCFP from policy making point of view. Using 15 years CCFP monitoring households' panel dataset and some parcel data, this paper is going to address those issues. It was found that CCFP has significantly contribute to CCFP' farmers' crop yield, initially build up linkage between forestry ecological and economic impacts.

Email: xiechen@forestry.gov.cn

The wetland conservation policies and its current evolution trend in China

Hui Wang, Chao He, Yali Wen
School of Economics and Management, Beijing Forestry University

Wetland ecosystem is the one of the three largest ecosystem in the terrestrial ecosystem and has played an important role in human-environment system. In China, wetland has been overused, and its area and quality has been threatened. So it is important for China to enforce wetland conservation strategy and policy, which is more important during the rapid progress of social and economic development. The paper will overview the wetlands policies in china, analyze its characteristics and problems, and its current evolution trend by the strategy evolution and practical problem.

Email: huiwang@bjfu.edu.cn

The analysis of socio-economic trend and its pressure across panda landscapes in China

Chao He, Hui Wang, Yali Wen
School of Economics and Management, Beijing Forestry University

The endangerment of Giant Pandas is mainly due to the decreasing, deteriorating, and fragmenting of their natural habitat, which caused by many social economic activities since the civilization times. The general disturbing factors across panda habitat from social system like cultivating, logging, graze, cutting firewood and other 13 kinds of that were analyzed with encounter number and rate method; the large disturbing activities like villages, highway, tourist attractions, mine lots, hydropower stations and high voltage power lines were analyzed with GIS overlap and buffer method. The study found that 18.85% of the panda habitat was heavily influenced by six kinds of large disturbing activities, and cultivating, logging, graze, cutting firewood occupied the top of general disturbing factors.

Email: hechao@bjfu.edu.cn

Factors affecting the use of urban green spaces for physical activities: views of urban residents in Beijing

Changyan Yuan, Yali Wen, Chao He
Department of forestry economics and management, Beijing Forestry University

Residents of the largest metropolitan areas in Beijing were surveyed about the benefits and problems of trees in urban areas. We analyzed the factors that affect the residents' satisfaction levels when participating in physical activities in urban green spaces by using ordinal logistic regression. Responses from the 1062 survey participants indicated that low-intensity activities (e.g., walking, sightseeing) were the most common activities. For a compact city like Beijing, we recommended plans that focus on increasing the link among existing urban green spaces and improve the maintenance of residential green spaces in order to increase the use of urban green spaces for physical activities.

Email: ycy_eye@163.com

Monetary valuation of urban forest ecosystem services in China: achievements, problems and future research needs

*Xiang Li[1], Min Liu[1] *, Yuehua Wang[1] *, Bohai Wu[1], Jianzhi Niu[2], Qingfu Xiao[3], Gregory E McPherson[4], Natalie van Doorn[5]*

1. China National Forestry Economics and Development Research Center

2. School of Soil and Water Conservation, Beijing Forestry University

3. Department of Land, Air, and Water Resources, University of California, Davis

4. USDA Forest Service, Pacific Southwest Research Station, Davis, CA 95618, USA

5. USDA Forest Service, Pacific Southwest Research Station, Albany, CA 94710, USA

Urban forests are irreplaceable components of urban environment due to the ecosystem services it provides, including carbon sequestration, oxygen release, air pollutants removal, water regulation and recreation et al. These benefits are of great importance in China, where serious pollution and floods take place frequently. Therefore, urban forest ecosystem services have been widely monetarily evaluated in China since 1990s. This study focuses on the ecosystem services categories of urban forests, the monetary values in different cities, and valuation methodologies among previous researches. There are three key findings: 1) water regulations (rainfall interception and peak flow delay) and the recreation values (travel, education et al.) were mostly underrated and even completely overlooked; 2) no scientific standards were employed, resulting in that various methodologies were implemented when calculating the ecosystem services. Models like i-tree and CITYgreen have been widely introduced since 2005. However, most parameters and variables were still based on database of the US, which lowered the accuracy of monetary valuation in China. 3) Policies became a major driving force in urban forest cultivation and the related valuation of ecosystem services, particularly after 2012, which eco-civilization has been greatly promoted. In the future, the importance of methodologies should be fully recognized, and the effect of policies and management practices on urban forest ecosystem services should be summarized. These are critical to make cities in China more livable and sustainable.

Email: scy0418@163.com

Oral Presentations of All Division 8 Conference

Oral Presentations of All Division 8 Conference

Keynote Plenary Sessions

Will rising [CO_2] affect forest species and function in large-scale forest CO_2 enrichment experiments? The next-generation of forest experiments

David Ellsworth[1], Kristine Crous[1], Julia Cooke[2], Catriona Macdonald[1], Teresa Gimeno[3]
1. Western Sydney University, Australia
2. The Open University, United Kingdom
3. INRA, France

Rising atmospheric CO_2 concentration affects all global forests, with fundamental changes in ecosystem C, water and nutrient cycles hypothesised All of these can interact with aspects of climate change elicited by rising [CO_2]. Many of these potential changes are expected to occur within the next 50 years as CO_2 concentrations exceed 570 parts per million (ppm), nearly 50% more than the current global CO_2 levels. Here we ask, i) what are the changes in forest functioning that are forecast with rising atmospheric CO_2, ii) what is the evidence from forest ecosystem experiments for these changes, and iii) will these changes matter in terms of altering forest species composition? An acceleration by 20-40% of forest ecosystem C cycling with a ~50% increase in [CO_2] is evident from recent experiments, driving a cascade of biogeochemical changes downstream from forest productivity including decreases in forest canopy N and P pools. The latter have important implications for long-term sustainability in nutrient-limited forests. However, evidence from mature forest ecosystems under elevated CO_2 suggests surprisingly small (< 15%) changes in transpiration and water savings and hence little hydrological alteration despite several years in elevated CO_2. The next-generation of forest elevated CO_2 experiments around the world aims to solidify how nutrient-limitations constrain the CO_2 enhancement response in forest production to allow for better forest management in the coming decades as global atmospheric [CO_2] tops 500 ppm.

Effects of climate change and disturbances on forests of Northeastern China and Eastern U.S.

Hong S. He
Northeast Normal University, China

Climate change, fire, and timber harvest are arguably the most significant factors driving forest change. Studies suggest that relative importance of fire, harvest, and climate change may vary by forest ecosystems. Our objective was to investigate responses of forests in Northeastern China and Eastern U.S. to fire, harvest, and climate change to understand the relative importance of these factors. We applied a framework of coupling forest ecosystem and landscape models to simulate about 200 million ha forest areas in both counties at 100-300 m spatial resolution for 150 years. Specifically, we evaluated the effects of fire, harvest, climate change, and their interactions on tree species distribution, density, basal, area, importance, and ecosystem carbon stocks in both regions. We found that succession was the primary driver of forest composition change over the next 150 years. The effects of harvest on composition were more important than climate change in the short term but climate change became more important than harvest in the long term.

Fire was much more important in Northeastern China forests than in Eastern U.S. forests. The study provided basis for designing adaptive forest management to minimize risk and promote ecosystem resilience under climate change.

Biodiversity and regulating ecosystem services in forests

Herve Jactel[1], Johana Boberg[2], Damien Bonal[1], Eckehard Brockerhoff[3], Bastien Castagneyrol[1], Barry Gardiner[1], Jose Ramon Gonzalez[4], Julia Koricheva[5], Nicolas Meurisse[3]

1. INRA, France

2. SLU, Sweden

3. SCION, New Zealand

4. CTFC, Spain

5. University London, United Kingdom

It is now widely acknowledged that biodiversity provides many ecosystem services, i.e. the benefits human populations can derive from ecosystem structures and functions. One main ecosystem service category is the regulation of biological conditions which includes ecosystem resistance to pests, pathogens, invasive species, storms, drought, fires and more generally natural disturbances. However most evidence supporting the diversity - resistance hypothesis have been so far documented in grasslands. Here we review the current scientific knowledge about tree species diversity effects on forest health in the broadest sense of the term. Based on comparisons between tree monocultures and mixtures we present the global pattern of tree diversity effects on forest resistance to biotic and abiotic hazards. We also discuss about potential mechanisms underlying diversity - resistance relationships, including the insurance hypothesis, niche complementarity and facilitation, resource accessibility and multitrophic interactions. Finally we use the outcomes of our review to propose knowledge-based solutions for the establishment of more resistant mixed forest plantations through relevant tree species associations.

Session D8-02 (53): Response of forest ecosystems to climate change: results from experimental manipulations

Contrasting responses of heterotrophic and root-dependent respiration to soil warming in a subtropical plantation

Wang Hui, Liu Shirong

Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

Understanding how soil respiration (Rs) and its source components respond to global warming is crucial to better predict climate-carbon feedback. Besides the high spatial variability of Rs, we also do not know enough about how the complex soil processes regulate soil CO_2 fluxes under soil warming, particularly in the tropical and subtropical forest ecosystems. We conducted a soil warming experiment by applying a nearly 2°C increase in combination with ambient soil temperature as control for 3 years to a subtropical *Castanopsis hystrix* plantation. Heterotrophic respiration (Rh) was measured in deep trenched subplots (100 cm deep) that excluded root growth, while total Rs was measured in untrenched subplots. Root-dependent respiration (Rroot-dependent) was calculated by subtracting Rh from Rs. Data on Rs, Rh, and Rroot-dependent from January to December in 2014 were presented in this paper to minimize some potential problems involved in using root exclusion method. Soil warming significantly elevated Rh but decreased Rroot-dependent primarily in the dry–cool season, but soil warming had no significant influence on Rs, suggesting that there exists a seasonal response pattern of Rh and Rroot-dependent to soil warming. The contents of soil organic carbon (SOC) and total nitrogen significantly reduced by soil warming, whereas the contents of soil NH_4^+ and NO_3^- did not differ between warming and control treatments. A decrease in the amount of arbuscular mycorrhizal fungi (AMF) under soil warming was observed in the dry–cool season, although fine root biomass was not influenced by soil warming. The amounts of other soil microbial groups did not change under soil warming. The non-significant change in soil moisture and the decreased amount of AMF under soil warming in the untrenched subplots could counteract the positive response of SOC decomposition to soil warming, and it probably is the reason of the neutral response of Rs to soil warming. Our study highlights that AMF in addition to soil temperature and moisture play an important role in shaping responses of Rs and its components to soil warming.

Email: wanghui@caf.ac.cn

Differential responses of soil respiration to soil warming and experimental throughfall reduction in a transitional oak forest in central China

Liu Yanchun[1,2], Liu Shirong[1], Wan Shiqiang[2],
Wang Jingxin[3], Luan Junwei[4], Wang Hui [1]
1. Key Laboratory of Forest Ecology and Environment, China's State Forestry Administration，Research Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry
2. College of Life Science, Henan Key Laboratory of Plant Stress Biology, Henan University
3. Division of Forestry and Natural Resources, West Virginia University
4. Sustainable Resource Management, Memorial University of Newfoundland

Examining responses of soil respiration to climate change is crucial for understanding future terrestrial carbon (C) cycling. However, the interaction between climate warming and reduced precipitation on soil respiration has not been well documented. This study aimed to determine the impact of soil warming and throughfall reduction on soil respiration and its components (heterotrophic respiration and autotrophic respiration).

A field manipulative experiment with soil warming and throughfall reduction was conducted in an oak forest (*Quercus aliena*) at a transitional climatic zone in central China during the growing seasons (May–November) in 2011 and 2012. Soil temperature was elevated by 1.23–1.66°C relative to the ambient environment by using infrared heaters, and throughfall was reduced by 50 % through roof interception.

There were significant interactive effects of soil warming and throughfall reduction on soil respiration and autotrophic respiration in both 2011 and 2012. Soil warming substantially elevated soil respiration by 32.0–46.3% and autotrophic respiration by 57.8–63.2 % without throughfall reduction, respectively, but suppressed both of them with throughfall reduction. Throughfall reduction increased soil respiration by 16.2–37.2% and autotrophic respiration by 62.9–97.7% under ambient temperature, whereas decreased them by 13.7–29.2% and 22.6–51.9% under soil warming. Heterotrophic respiration was significantly increased by soil warming while it showed little effects by throughfall reduction or its interactions with soil warming. The offset of the positive warming effect on soil respiration under throughfall reduction may be attributed mainly to the changes in soil microbial biomass and fine root biomass induced by throughfall reduction. Our observations suggest that either climate warming or precipitation reduction may increase soil CO_2 emission, but this stimulation will be largely counteracted if climate warming should be accompanied with simultaneous precipitation reduction at the climatic transitional zone.

Email: liu_yan_chun@126.com

Understanding the consequences of climate change in remote mountain regions: a roof experiment to simulate monsoon failure in the Himalayas

Norbu Wangdi[1,2], Mani Prasad Nirola[1,4], Mathias Mayer[1], Iftekhar Uddin Ahmed[1], Norbu Zangmo[2], Karma Orong[2], Andras Darabant[1], Robert Jandl[3], Andreas Schindlbacher[3], Georg Gratzer[1]

1. Institute of Forest Ecology,University of Natural Resources and Life Sciences, 1180 Peter Jordan Strasse ,Vienna, Austria

2. Ugyen Wangchuck Institute for Conservation and Environmental Research, Department of Forests and Park Services Lamai Goempa, Bumthang, Bhutan

3. Federal Research and Training Centre for Forests, Natural Hazards and Landscape – BFW,A-1131 Vienna, Austria

4. National Biodiversity Center, Ministry of Agriculture and Forests,Thimphu, Bhutan

The Indian summer monsoon is a tipping element in the world’s climate. A sixth of the world’s population depends on its precipitation. The Himalayas are predicted to experience more than three times the mean global rise in temperature, as well as erratic rainfall patterns and an increased likelihood for total monsoon failures, so called mega-droughts. While many ecosystem manipulation experiments aiming at understanding the effects of altered precipitation, temperature and CO_2 levels have been conducted in North America and Europe, such experiments are scarce in South Asia. So far, the effects of altered precipitation on ecosystems in the Himalayas have not been characterized experimentally.

Thus, to fill this gap, we are simulating late onset of the monsoon precipitation as well as total monsoon failures in a multi-year drought stress experiment in Bhutan. With these experiments, we hope to understand how altered monsoon precipitation alters ecosystem productivity, dynamics and ecosystem C fluxes. Our main objective is to characterize the ecosystem responses to drought in cool-temperate conifer and broadleaved forests along an altitudinal gradient in the Bhutan Himalayas. We will present first results after large-scale roof application during 2014 and 2015. Our focus will be on drought effects on soil processes and soil CO_2 efflux.

Email: norwangs@gmail.com

Fate of deposited N in a tropical rainforest in Southern China

Wang Ang[1,2], Fang Yunting[1], Chen Dexiang[2]

1. Institute of Applied Ecology, Chinese Academy of Science

2. Research Institute of Tropical Forestry, Chinese Academy of Forestry

Effects of anthropogenic nitrogen (N) deposition and the ability of terrestrial ecosystems to store carbon (C) depend in part on the amount of N retained in the system and its partitioning among plant and soil pools. However, conventional methods (such as chronic nitrogen additions) cannot trace the fate of deposited N. In this study, we added the stable isotope ^{15}N in the form of $^{15}NH_4NO_3$ and $NH_4{}^{15}NO_3$ to a tropical rainforest ecosystem in southern China to study the fate of

the different forms of deposited N. Three months after the tracer application, the total ^{15}N recovery from the major ecosystem compartments were 60% and 57% for $^{15}NH_4NO_3$ and $NH_4{}^{15}NO_3$, respectively (without considering recovery of woody tissues). Forest floors and soils were the dominant sinks for both ammonium and nitrate tracers, accounted for 54% and 45% respectively. The amount of 15N assimilated into tree biomass was greater of the $^{15}NO_3$ tracer treatment (12%) than that of the $^{15}NH4$ treatment (6%). We calculated the C sequestration efficiency stimulated by N deposition was 12 kg C/kg N, lower than temperate forests. Our results suggested that studied tropical forest can retain deposited N, but N deposition is likely to make a minor contribution to carbon sequestration.

Email: studentwangang@126.com

Responses of understory plant diversity to long-term nitrogen and phosphorus addition in an old-growth tropical forest in South China

Mao Qinggong
South China Botanical Garden, Chinese Academy of Sciences

Increasing studies have been done to understand the responses of ecosystem processes to altered nitrogen (N) and phosphorus (P) availability. However, there remains unclear on how long-term N and/or P enrichment shape understory plant diversity in tropical forests. We tracked the understory species since 2008, after a N × P factorial addition experiment was established in an old-growth tropical forest in Dinghushan, South China. Each year, the richness, abundance and cover of species were recorded in all permanent plots. Results showed that both N addition and P addition decreased the understory plant diversity (richness and abundance), but effect of N and P addition showed different patterns. N addition was less selective on decreasing species density, while P addition was selective on decreasing the density of those relatively rare species. We further found that the vine was less sensitive to both N and P addition among all functional groups (seedling, shrub, vine and herb). Our results suggest that N- and P may drive species loss by independent mechanisms in the understory layer of old-growth tropical forests, and the P-depleted condition may greatly contribute to sustaining the high diversity in tropical forest.

Email: maoqinggong@qq.com

Soil warming experiments in subtropical forests in China: preliminary results

Li Yiqing, Yang Yusheng, Xie Jinsheng, Chen Guangshui, Lin Chengfang, Liu Xiaofei, Xiong Decheng, Lin Weisheng, Xu Chao
Fujian Normal University

Forests in the tropical and subtropical regions have the fastest growth rates in the world and thus a higher potential of carbon sequestration per unit of area in comparisons with temperate areas in higher latitudes. Their function of acting as a C reservoir and sequestering significant amount of atmospheric CO_2 has been widely recognized. However, much uncertainty exists on whether or not the tropical and subtropical forests will continue to do so under future global warming. In order to provide scientific information for potential changes in subtropical forest production and decomposition in the future we established soil warming experiments in plantations and natural forests in Fujian province, China. Our longest-running soil warming experiment assesses forest response to warming with an emphasis on soil processes (e.g., decomposition, microbial activities, trace gas fluxes) that could alter ecosystem function, atmospheric chemistry, and global climate. Initial treatments included: soil temperature raised 5°C above ambient with heated cables, soils with cables but no heating (disturbance control), Nitrogen fertilizer addition (manipulate N deposition), heating plus N addition, control plots. After two years' observation and measurements we found some very interesting results that were different from the temperate or boreal forests. Here we list some of the results: warming decreased seedling growth with significant warming and N addition interaction; accelerated fine root turnover; decreased root biomass but increased root length; heating and nitrogen interaction inhibited soil heterotrophic respiration; Soil warming enhanced CO_2 production from subsoil; Soil warming increased vegetation C pool by 110%; Soil warming decreased species biodiversity in natural forests, etc. In conclusion, the soil warming experiments in subtropical China provided us first-hand valuable information on potential changes in forest ecosystem functions under future global warming.

Email: yiqing@hawaii.edu

Little effect on soil organic matter chemistry of density fractions after seven years of soil warming in a temperate mountain forest

Jörg Schnecker[1,4], Werner Borken[2], Andreas Schindlbacher[3], Wolfgang Wanek[4]

1. Department of Natural Resources and the Environment, University of New Hampshire

2. Department of Soil Ecology, University of Bayreuth, Bayreuth, Germany

3. Department of Forest Ecology, Federal Research and Training Centre for Forests, Natural Hazards and Landscape - BFW, Vienna, Austria

4. Department of Microbiology and Ecosystem Science, University of Vienna, Vienna, Austria

Rising temperatures enhance microbial decomposition of soil organic matter (SOM) and increase thereby the soil CO_2 efflux. Elevated microbial activity might differently affect distinct SOM pools, depending on their stability and accessibility. Soil fractions derived from density fractionation have been suggested to represent SOM pools with different turnover times and stability against microbial decomposition. We here investigated the chemical and isotopic composition of bulk soil and three different density fractions of forest soils from a long term warming experiment in the Austrian Alps. At the time of sampling the soils in this experiment had been warmed during the snow-free period for 7 consecutive years. During that time no thermal adaptation of the microbial community could be identified and CO_2 release from the soil continued to be elevated by the warming treatment. Our results which included organic C content, total N content, δ13C, δ14C, δ15N and the chemical composition, identified by pyrolysis-GC/MS, showed no significant differences in bulk soil between warming treatment and control. The differences in the three individual fractions (free particulate organic matter, occluded particulate organic matter and mineral associated organic matter) were mostly small and the direction of warming induced change was variable with fraction and sampling depth. We did however find statistically significant effects of warming in all density fractions from 0-10 cm depth, 10-20 cm depth or both. Our results also including significant changes in the supposedly more stable mineral associated organic matter fraction where δ 13C values decreased at both sampling depths and the relative proportion of N-bearing compounds decreased at a sampling depth of 10-20 cm. All the observed changes can be attributed to an interplay of enhanced microbial decomposition of SOM and increased root litter input.

Email: joerg.schnecker@unh.edu

Session D8-02 (5): Invasive species and forest ecosystems under changing climate: ecological, economic and social impacts

Comparison of insect invasions in North America, Japan and their islands

Andrew Liebhold[1], Takehiko Yamanaka[2]
1. US Forest Service Northern Research Station
2. Japan National Institute for Agro-Environmental Sciences

Insects comprise the largest taxa of animals and not surprisingly there are more insect invasions than any other animal group worldwide. We compared the compositions of the native and non-native insect communities among five Pacific regions: North America, the Hawaiian Islands, mainland Japan, Ogasawara and Okinawa Islands. Among the five regions, the oceanic islands, Hawaii and Ogasawara, appear to be the most prone to invasions. Specific insect orders such as the *Blattodea, Siphonaptera, Thysanoptera and Hemiptera* are disproportionally represented in the non-native insect fauna compared to the native fauna in all regions. A large fraction of the non-native insect species in North America and Hawaii were introduced intentionally, for the purpose of biological control, which has been more strongly pursued there than in Japan. Dominance by individual insect orders within invaded communities can be explained by the historical importance of invasion pathways which are shared among the regions. Patterns of movement of species among regions can also be explained in part by climatic similarity, host plant similarity and propagule pressure.

Email: aliebhold@fs.fed.us

Distribution and impact of alien shrub species in forest of Lithuania under changing climate

Vitas Marozas, Kristina Gritytė-Pratašienė
Aleksandras Stulginskis University

Some alien species used in forestry may cause major problems as invaders of natural and semi-natural ecosystems. The magnitude of the problem has increased significantly over the past few decades, with are rapid increase in afforestation, climate and land use change. Invasive tree or shrub species can affect all components of an environment, from ecosystem processes to community structure and biodiversity patterns. They can limit native plant growth or change species composition. The degree to which the alien species influences the ground vegetation depends on the individual species. Several introduced species appear to have the capacity to develop new self-perpetuating vegetation types out of semi-natural vegetation. The aim the study was assess distribution, vegetation and site parameters of the most common alien shrub species in Lithuanian forest ecosystems. Data on alien shrub species abundance and distribution were obtained from the forest inventory database. It was found that the most spread alien species were: *Sambucus sp*. *Amelanchier spicata* and *Sarothamnus scoparius. Amelanchier spicata* dominated in northern part of eastern Lithuania, while *Sambucus* species were most spread in the southern part of the country. Alien shrub species were most widespread in fresh soil and pine forests.

Email: vitas.marozas@asu.lt

Invasive alien plants in the forests of India with special reference to the woody perennials

Daizy Batish[1], Shibu Jose[2]
1. Panjab University
2. University of Missouri

Forests play a vital role in sustaining human life by providing numerous ecosystem services. Unfortunately, these are fast dwindling owing to several reasons including the threats posed by invasive plants. These deplete biodiversity, interfere with the ecological processes and make forest operations difficult. In India, several invasive plants including herbs, shrubs and trees have encroached the forest areas. However, woody perennials pose the major threat to the forest ecosystems. Of these, Lantana camara - an ornamental shrub, is one of the worst invaders of the forest ecosystems. *Sapium sebiferum, Broussonetia papyrifera, Leucaena leucocephala* and *Prosopis juliflora* are the other woody invasive species that are troublesome in these forests. In addition, the invasive plants like *Ageratina adenophora, Parthenium hysterophorus* and *Hyptis suaveolens*, though herbaceous in nature but possess a tendency to be perennial. Their adverse impact on the forests or at the forest-urban interface or along forest margins is significantly noticeable. Several native species either get replaced or eliminated and consequently, there are alterations in the structure and composition of the native vegetation. These changes further affect various ecological processes. During the deliberations of the conference, it is proposed to discuss various aspects of the woody invasive plants in forest ecosystems.

Email: daizybatish@yahoo.com

Plant invasion in Indian Northwestern Himalayan region

Vikrant Jaryan[1], Dazy Rani Batish[1], Harminder Pal Singh[2], Sanjay Kumar Uniyal[3]
1. Department of Botany, Panjab University, Chandigarh, India
2. Department of Environment Studies, Panjab University, Chandigarh, India
3. Biodiversity Division, Institute of Himalayan Bioresource Technology,Palampur 176061 HP, India

Biological Invasion is a worldwide phenomenon and currently no part of the world is untouched. Indian Northwestern Himalaya is comprised of three Himalayan states namely Jammu and Kashmir, Himachal Pradesh and Uttarakhand with an area 3,33,392 sq Km. Based on recent publications, the number of alien invasive plant species present in Kashmir Himalaya is 96, Himachal Pradesh is 144 and Uttarakhand is 163. Prominent invasive species in Himalayan region are Lantana camara, *Ageratum conyzoides*, *Parthenium hysterophorus* and *Ageratina adenophora.* Anthropogenic pressure, rapid urbanization and increasing demands of forest products are the main cause of habitat destruction and spread of invasive species. We have identified some new invasive species *Bidens pilosa*, *Cannabis sativa*, *Chenopodium album*, *Duranta erecta, Sapium sebiferum, Senna tora, Xanthium strumarium, Solanum viarum, Ricinus communis, Imperata cylindrica* in three types of sites: human settlements, mesic area and forest area which are spreading in the Himalayan region. *Sapium sebiferum* had established itself as an emerging invasive species acquiring 4,611 sq Km area in Himachal Pradesh whereas Ecological Niche Modeling (ENM) based on Maxent shown >3% geographical area of western Himalaya under invasion. The need of hour is heavily demanding the ecological and economic assessment of these invasive species so that valuable information generated can be useful for the people of this region. Further research work is focused on categorization of invasive species on the basis ground data which can be useful for drafting the sustainable management in the Shivalik region of western Himalaya.

Email: vikrantjaryan@gmail.com

Plant functional traits provide advantage to alien invasive tree *Broussonetia papyrifera* over the non-invasive tree Morus alba

Harminder Pal Singh[1], Anjana Negi[1], Ravinder Kumar Kohli[1,2]
1. Panjab University
2. Central University of Punjab

Broussonetia papyrifera (Paper Mulberry; Moraceae), a woody perennial from Japan and China, is spreading very fast in Shivaliks hills (North-western Himalayas, India). In contrast, *Morus alba*, another member of *Moraceae*, is non-invasive. We investigated the role of plant functional traits in imparting invasive nature to *B. papyrifera* and compared with those of non-invasive *M. alba*. Various leaf traits determined were specific leaf area (SLA), tissue density, leaf thickness, leaf length, width and fresh and dry biomass. The tree related traits included tree height, % cover, diameter at the breast height (dbh), allelopathic and reproductive ability. Invasive tree *B. papyrifera* had higher growth, dbh and % cover and reproductive ability in terms of number, size and weight of seeds and their dispersal and vegetative growth. SLA and other leaf related parameters were also significantly different in the two types of trees. The rhizospheric soil of *B. papyrifera* significantly inhibited the growth of *Bidens pilosa*, whereas there was little effect of soil brought from under the canopy of M. alba. The study concluded that *B. papyrifera* (invasive tree) differ from non-invasive M. alba with regards to various functional traits, thereby indicating their role in imparting invasiveness to the species.

Email: hpsingh_01@yahoo.com

***Imperata cylindrica* invasion of the longleaf pine (*pinus palustris*) forests of the U.S Southeast: impacts on resource availability, understory plant diversity and ecosystem productivity**

Shibu Jose
University of Missouri

Cogongrass (*Imperata cylindrica (L.) Beauv.*), a perennial grass native to Southeast Asia, has become one of the most notorious exotic pests in the southeastern U.S.? The forestlands in the Southeast are being occupied by this non-indigenous species at an alarming rate threatening their ecological integrity.? Field and greenhouse trials have demonstrated that cogongrass can decrease species diversity, alter soil physico-chemical and microbial properties, and decrease productivity of natural and planted pine forests of the South. Based on data collected from multiple trials over the past 15 years, this presentation will explore the mechanisms by which cogongrass gains dominance over native species and its subsequent ecological impacts to the structure and function of invaded ecosystems, particularly the longleaf pine ecosystem, an endangered ecosystem in the United States.

Email: joses@missouri.edu

Session D8-02 (46): Wind disturbance and forest sustainability under a changing climate

Wind risk and forest intensification in a changing climate

Barry Gardiner
1. INRA
2. EFIATLANTIC

The global demand for wood is rising and projected to increase by between 1.3 % and 1.8 % up to 2030. This increased demand can only be satisfied by plantation forests and the challenge is to intensify the productivity from these forests in a sustainable and resilient manner. Such forests have to be able to be resilient in the face of a changing climate and the shocks cause by damaging events such as wind storms. This requires us to use our best understanding of forest ecosystem functioning to design forest management systems that are resilient enough to ensure the long-term productivity of forests. In this paper we discuss the potential risks to plantation forests from wind and how these risks are likely to change with increasing intensification. We then discuss how these risks can be mitigated through choice of species and changes in management practice. In particular the paper will focus on the impact of using mixed species and mixed structure forests on wind risk and the potential benefits and disadvantages of such a management approach.

Email: barry.gardiner@bordeaux.inra.fr

Forest wind damage from tropical cyclones

Kana Kamimura[1], Masaya Kato[2], Mayumi K. Yoshioka[2], Satoshi Suzuki[3]
1. Institute of Mountain Science, Shinshu University, Japan
2. Institute for Space-Earth Environmental Research (ISEE), Nagoya University, Japan
3. Forestry and Forest Product Research Institute, Japan

Forests are enormously damaged by not only biotic but also abiotic causes, in particular strong wind and rain from tropical and sub-tropical cyclones. To mitigate damage risk in order to achieve sustainable forest managements, several studies have been conducted based on mechanistic and statistical approaches that use mechanical properties of trees, tree characteristics, environmental and forest condition factors, forest management activities, aerodynamics, and observations of damaged trees and forests. However, these approaches often require a certain amount of observed damage data consisting of various forest and environmental types in order to validate or create models. More importantly, there is very limited information about the direct relationship between wind damage occurrences in forests and weather conditions. Without considering these points, utilizing the models for developing forest management strategies in the future would not be straightforward. Therefore, in this research we aim two objectives: 1) to analyse long-term forest damage from tropical cyclones and 2) to understand how single tropical cyclone events have caused damage in forests.

First, the long-term forest damage inventory data is spatially analyzed. In Japan, the Forest Agency has recorded forest damage since 1954 (Suzuki et al. 2009). This data is first transformed to digital data for spatial and temporal analysis to show the temporal change of wind damage at prefecture (1954-1978) and town (1979-2011) levels and also spatial change of damage at a country level. Second, forest damage from tropical cyclones observed in 2004 are analyzed. In 2004, two strong tropical cyclones landed on Japan and caused catastrophic damage in many forests. To analyze how tropical cyclones directly resulted damage in many regions, we specifically focus on one of these damage events. We have estimated wind speeds from the tropical cyclone using Cloud Resolving Storm Simulator (CReSS), which is a non-hydrostatic and compressible model to simulate cloud and precipitation systems (Tsuboki 2008). The estimated wind speeds at a resolution of 2.5 km x 2.5 km covering the boundaries of Japan are compared with the spatial data of wind damage in forests. We will present the primary results of long-term changes from wind damage in forests and the detailed relationship between tropical cyclones and forest damage by coupling statistical and numerical models.

Email: barry.gardiner@bordeaux.inra.fr

Long-term interactions between wind disturbance, climate change, and forest management

Werner Rammer, Katharina Albrich, Rupert Seidl
Boku University Vienna, Austria

Wind is the most detrimental disturbance agent in Europe's forests, and its impact is projected to further increase in the coming decades. Anthropogenic climate change may thus not only affect forest dynamics in general, but also profoundly alter disturbance regimes. In this context it remains unclear how forest management can best ensure long-term ecosystem service provisioning. We here use iLand, the individual based forest landscape and disturbance model to study the effect of different management regimes. iLand includes a process-based module of wind disturbance that operates on the level of individual trees and explicitly simulates the propagation of wind disturbance on a landscape. Furthermore, iLand simulates biotic disturbance agents (bark beetles) and includes an agent-based forest management module. We've here used the model to study a 6,500 ha landscape in Austria, for which we simulated four contrasting management strategies under both current and changing climatic conditions. The results show that risk mitigating management strategies were considerably less affected by disturbances compared to timber production oriented strategies. However, the simulations revealed also a clear trade-off between risk mitigation and forest productivity.

Email: barry.gardiner@bordeaux.inra.fr

Changing forest wind risk in a changing climate

John R Moore
Scion

Wind is a major disturbance in natural and managed forests in many regions of the world. In broad terms the risk of wind damage is a function of the extreme wind climate, the structure of forests and site conditions (e.g. soil properties). Under future predicted climate change, both the frequency and magnitude of extreme winds are likely to increase in many parts of the world. In addition, changes in temperature, rainfall and CO_2 concentrations may lead to increases in growth rates of forests, so that they reach a more vulnerable state sooner that they do under current conditions. Some forests growing in boreal regions may experience longer periods in the winter when soils are not in a frozen condition, which will impact on tree stability.

The potential effects of future climate change on the risk of wind damage is not as well understood as they are for other risk agents such as drought, fire and disease spread. However, researchers are now starting to integrate the outputs from climate models, process based growth models and mechanistic wind damage models to better understand the potential magnitude of the change in the risk of wind damage, the key drivers of this change (i.e. increasing frequency and magnitude of extreme wind events vs. increased forest growth rates creating more vulnerable stands), and to develop potential mitigation strategies.

This presentation will give an overview of the impacts that future climate change might have on the risk of wind damage with a particular focus on managed forests. It will also highlight how existing models can be used to attempt quantify the impact of future climate change on wind damage risk and to aid in the development of mitigation options to better manage this risk.

Email: john.moore@scionresearch.com

Effects of wind damage on the optimal management of boreal forest under the current and changing climate

Ane Zubizarreta-Gerendiain[1,2], Timo Pukkala[1], Heli Peltola[1]
1. School of Forest Sciences, Faculty of Science and Forestry, University of Eastern Finland
2. Basque Centre for Climate Change

This study analyzed the effect of wind damage on the optimal management of a boreal forest landscape under the current climate and changing climate, assuming that the mean annual temperature will increase by 4℃ , precipitation by 10%, and atmospheric CO_2 concentration by 272 ppm by 2070–2100 compared to the current climate with atmospheric CO_2 concentration of 360 ppm (period 1960–2000). The effect of wind damage on timber production, carbon balance, and economic profitability of forestry was also calculated. A reference plan maximized the net present value (NPV) with even-flow harvesting constraints. Alternative problem formulations minimized height differences between adjacent stands as the only objective or aimed simultaneously at maximal NPV. The fourth plan maximized height differences between adjacent stands. To obtain damage-adjusted results, schedules that belonged to the optimal management plans were simulated again including simulation of wind damage. The shelter provided by adjacent stands was taken into account in these simulations. The highest damage-adjusted NPV was obtained by maximizing NPV and simultaneously minimizing height differences. Increasing wind damage increased the carbon balance of forest soil. However, wind damage decreased the total carbon balance of forestry as it decreased the carbon balances of living forest biomass and wood-based products. Climate change slightly improved the total carbon balance of forestry. If wind damage was ignored in calculations, the NPV, total carbon balance of forestry, and timber production were all overestimated.

Email: Heli.Peltola@uef.fi

Impacts of tree species preference on regional wind damage risks to Finnish forests under changing climate

V.-P. Ikonen[1], A. Zubizarreta-Gerendiain[1,2], A. Kilpeläinen[1], H. Strandman[1], A. Asikainen[3], A. Venäläinen[4], J. Kaurola[4], H. Peltola[1]
1. School of Forest Sciences, University of Eastern Finland
2. Basque Centre for Climate Change
3. Natural resources Institute Finland
4. Finnish Meteorological Institute

We studied the impacts of tree species preference in forest regeneration on the regional wind damage risks to Finnish forests under the changing climate. We employed forest ecosystem model (SIMA) simulations as input for prediction of critical wind speeds for uprooting at the newly cut forest edges by the mechanistic wind damage risk model (HWIND). Business as usual management included regeneration with the same tree species present before final cut. In alternative management regimes either Scots pine, Norway spruce or birch was preferred in regeneration on medium fertile sites on Finnish national forest inventory plots. The current baseline climate and two climate change scenarios (RCP4.5 and RCP8.5) were used for 2010–2099. The current forest structure and preference of tree species affected largely the regional wind damage risk. Climate change affected wind damage risk of forests only indirectly via its effects on forest dynamics and growth of trees. Preference of Scots pine and its large proportion decreased wind damage risk, opposite to Norway spruce. Preference of birch decreased wind damage risk in autumn (birch without leaves), opposite to summer (birch in leaf). Wind damage risk was clearly larger in southern Finland than in northern Finland. Wind damage risks should be considered in forest management, especially in southern Finland.

Email: Heli.Peltola@uef.fi

Wind disturbance and forest management at the landscape level

Jean-Claude Ruel, K.A. Anyomi, S.J. Mitchell
Centre d'Étude de la Forêt. Faculté de foresterie, de géographie et de géomatique, Université Laval

In ecosystems submitted to a maritime influence, fire occurrence is low and partial windthrow can be a significant disturbance shaping natural ecosystems. Recently, there has been a pressure to increase the use of partial cuts, including in old growth boreal stands previously left unmanaged. One limitation to this approach is the apprehension of windthrow. To better understand and predict the impacts of partial cutting in these forests, an experiment was put in place in old-growth balsam fir-black spruce forests of eastern Quebec, Canada. Four different silvicultural treatments were compared to a control and monitored for a 6-7 years period. In parallel, an adaptation of the FORESTGALES_ BC model was made in order to use it for eastern Canadian stands. Results and simulations show that basal area proportions damaged by windthrow differ substantially between treatments. Both field data and simulations show that the environment surrounding the partially cut plot has an influence over the amount of damage. Both field data and simulation also agree that balsam fir is likely to be more damaged than black spruce. Simulation demonstrates the importance of including damage propagation when trying to model windthrow.

Email: jean-claude.ruel@sbf.ulaval.ca

Why does wind-induced root acclimation matter to tree stability?

Ming Yang[1], Pauline Défossez[1], Frédéric Danjon[2], Thierry Fourcaud[3]
1. ISPA, Bordeaux Sciences Agro, INRA
2. BIOGECO, INRA, Univ. Bordeaux
3. CIRAD, UMR AMAP, Boulevard de la Lironde

This research examined the benefit in mechanical tree stability resulting from root acclimation induced by wind. Various forms of root plastic response to wind stimuli were observed for a wide range of woody species. However, their mechanical consequences on tree stability are difficult to estimate experimentally. Indeed, large variability in both root system architecture and site conditions introduces confounding factors when comparing anchorage performance of difference trees. Biomechanical modelling can be a workaround to reveal the connection between root adaptation and the anchorage function of the tree. We use a finite-element-based tree anchorage model to simulate tree below-ground response to stem bending. Root system architecture, root material properties and soil properties are explicitly described in the model. Various observed forms of wind-induced root acclimation are expressed as local modification of root morphological or mechanical properties. The positive impacts on tree stability due to these local root modifications are quantified as the gain of tree anchorage strength and the gain of anchorage rigidity. Key factors of root acclimation associated with tree anchorage will be determined and discussed in this study.

Email: ming.yang@bordeaux.inra.fr

Session D8-03 (93A), D8-04 (93B): Forest carbon sequestration

Forest carbon sequestration

Li Nuyun
China Green Carbon Foundation

Global climate change has become one of the most urgent environmental issues in the world. With the development of global climate change negotiations, the important function of forest for combating climate change has been accepted gradually by international community. Forest carbon trade can be used as an altanative way to fulfil developed country's obligations in terms of emission reduction specified by the Kyoto Protocol. Chinese society has given great importance to forest carbon trade for combating climate change and improving environment. China Green Carbon Foundation (CGCF), as the first national public non-profits fund targeting on addressing climate change by increasing carbon sink and reducing carbon emission through forest means, has made some methodologies on forest carbon sequestration projects, implemented different types of forest carbon pilot projects, conducted voluntary forest carbon trade as well. Those experiences will benefit the upcoming national carbon trade system next year and open a new finance channel to boost the construction of ecosystem and eco-civilization.

Email: pagedow@126.com

Carbon sequestration in managed bamboo forests

Zhou Guomo
Zhejiang A & F University

Bamboo forests are widely distributed in the tropical and sub-tropical regions, and have a great carbon sequestration capacity. The carbon storage and carbon cycles of bamboo forests have been a research focus in the adapting and mitigating climate change field. This presentation provides an overview of the feature and ability of bamboo forest in carbon capture, key techniques for estimating and predicting carbon sequestration of bamboo forests and methodologies for carbon accounting and monitoring of bamboo forests, based on studies conducted by our team over the past 15 years.

Moso bamboo ecosystem has a carbon stock 106.36 Mg C ha^{-1}, among which vegetation carbon stock is 34.89 Mg C ha^{-1} accounting for 32.80%. Based on the scenario simulation, Moso bamboo forests in China stored 611.2 ± 142.3 Tg C, and the potential carbon stocks of which reaches 1331.4 ± 325.1 Tg C. The carbon storages of the ten main bamboo species in China ranged from 86.30 Mg C ha^{-1} to 181.81 Mg C ha^{-1}. The global bamboo forest was classified using multi-source remote sensing, and the classification accuracy of global bamboo forest extracting was 79.81%, and the area accuracy was 92%. Based on the carbon density of bamboo forest ecosystems in China, the estimated global bamboo carbon stock is about 4 Pg, accounting for 0.4%-0.6% of the total global forest carbon stock. Two methodologies, “Bamboo Afforestation Methodology for Verified Carbon Reduction” and “Bamboo Management Methodology for Verified Carbon Reduction”, were officially endorsed by the National Development and Reform Commission in 2013 and 2015, respectively.

Email: zhougm@zafu.edu.cn

Impacts of fertilization on soil C, N and P in loblolly pine plantations in the southeastern United States

Thomas Fox
Virginia Tech University

We examined the effects of repeated applications of nitrogen (N) and phosphorus (P) fertilizer over a 12-year period on C, N and P in the O horizon and mineral soil in loblolly pine (*Pinus taeda L.*) plantations at 9 experimental sites located across the south. Soils at these sites were classified into three groups based on soil texture and drainage class: Group 1—poorly-drained Ultisols; Group 2—Spodosols and Entisols; and group 3—well-drained Ultisols. Fertilization rates were 0, 135, 202, and 269 kg N ha^{-1} applied at four-year intervals. This resulted in a cumulative N application rate of 540, 808, and 1076 kg ha^{-1} over the 12year study period. P was added at 10% of the N rate at each application date. Fertilization increased the C, N content, and P content of the O horizon in all soil groups. Fertilization did not impact mineral soil C or N. No significant increases in total C or N were observed to a depth of 1 m. Likewise, total inorganic N (NH_{4+} + NO_{3-}) was not affected by fertilization. n contrast, fertilization increased Mehlich 3 extractable P in soil groups 1 and 2, but not soil group 3. Extractable P increased by 26, 60, and 4 kg P ha^{-1} respectively in soil group 1, 2 and 3. These results suggest that N fertilization will have little effect on long-term C or N availability in the mineral soil regardless of soil types. P fertilization will increase long-term soil P availability on some soil types in the South.

Email: trfox@vt.edu

Long-term biosolids application increased tree growth and carbon sequestration of radiata pine plantation on a marginal land

Jianming Xue[1], Mark Kimberley[2]
1. Scion, Private Bag 29237, Christchurch
2. Scion, Private Bag 3020, Rotorua

The objective of this study was to investigate the effects of long-term biosolids application on radiata pine growth and total carbon storage in biomass and soil of a marginal site. A research trial was established in a radiata pine plantation growing on a sandy soil at Rabbit Island near Nelson, New Zealand, in 1996. Biosolids were applied to the trial every three years since 1997, at three application rates: 0 (Control), 300 (Standard) and 600 kg N/ha (High). Biosolids application significantly increased foliar N concentration and tree stem volume growth since 1998. Compared to the Control, total carbon storage in the stand at age 24 years was increased by 25% and 28% for the Standard and High rates, respectively. Both the Standard and High rates significantly increased soil total C, N, and P, Olsen P and CEC, but reduced soil PH. Our results indicate that long-term application of biosolids could significantly improve soil fertility and pine productivity on a marginal site, with increased carbon storage in the radiata pine stand and the soil. This study suggests that beneficial use of biosolids on marginal land was an effective means of increasing carbon sequestration in the pine forest and sandy soil.

Email: jianming.xue@scionresearch.com

Carbon sequestration in soils of boreal forest ecosystems of Central Siberia

Liudmila Mukhortova[1], Leonid Krivobokov[1], Maria Meteleva[1], Estella Vedrova[1], Olga Shibistova[1], Georg Guggenberger[2,1]
1. V.N.Sukachev Institute of Forest, the Siberian Branch of the Russian Academy of Sciences, Russia
2. Institute of Soil Science Leibniz Universität Hannover, Germany

To assess impact of environmental conditions on organic carbon(OC) and nitrogen(N) in permafrost soils, we compared OC stock in soil and forest floor vegetation on south-eastern(SE) and north-eastern(NE) slopes dominated by larch forests on soils developed from igneous rocks. Soils of the SE aspect stored more OC and more N than their counterparts at NE exposition. Also soils underlain by permafrost stored less OC and N in the active layer than those that do not reach the permafrost. As the organic matter in soils with smaller OC and N storage was less degraded, these differences in OC and N storage cannot be due to the lower microbial activity. Just in opposite, in northern taiga soils under study, the higher OC and N storage can be rather due to higher litter input and higher general soil biological activity under more favorable conditions. We suppose that more pronounced incorporation of litter into the mineral soil with bioturbation is of utmost importance for the stabilization of organic matter. With that permafrost soils developed from igneous rocks behave quite differently to those formed in sediments, which must be considered in upscaling potential OC losses due to permafrost degradation.

This research is supported by RFBR (No.14-04-01239_a and 16-04-01677_a) and by the Russian Government Megagrant Project No.14.B25.31.0031.

Email: l.mukhortova@gmail.com

Tree species diversity benefits soil C stability by depressing temperature sensitivity rather than rate of soil respiration

Luan Junwei[1], Liu Shirong[2], Wang Jingxin[3], Scott X. Chang[4], Lu Haibo[2], Liu Xiaojing[5], Yao Song[5], Wang Yi[1]

1. International Center for Bamboo and Rattan

2. Chinese Academy of Forestry

3. West Virginia University

4. University of Alberta

5. Baotianman Natural Reserve Administration of Henan Province

Given that diversity-stability theory of ecosystems, we hypothesis that tree species diversity will exert negative influence on the temperature sensitivity of soil respiration (Q10), which means that the higher tree species diversity will lead to higher resistance of soil carbon to the climate warming. We tested our hypothesis in both a secondary regenerated temperate forest and a pine plantation but without management for around 40 years. One 60 m × 80 m plot in each forest was established, a 10 m × 10 m square grid was then placed within each plot and 35 subplots (1 m × 1 m) were positioned at each intersection, where soil respiration was measured for one year in order to estimate the Q10. Tree species were recognized and positioned for each single tree appeared in the plot, in order to calculate the indexes of diversity, including Berger-Parker index (d), Margalef index (dMa), Simpson index (λ), Simpson index (Dr), Shannon index (He', H2'), Pielou evenness index (Je). Our results agree our hypothesis, for example, the spatial variability of Q10 was positively explained by the λ, and was negatively explained by the He', d, D, and Je for trees within 6 m radius of the measurement points. However, no relationship between diversity index and mean rate of soil respiration was found. Our findings indicate that tree species diversity benefits soil carbon stability by depressing temperature sensitivity rather than rate of soil respiration.

Email: junweiluan@icbr.ac.cn

The effects of thinning and understory vegetation removal on litterfall and fine root biomass at three coniferous plantations

Byung Bae Park[1], Ji Young An[2], Siho Han[1], Joo Han Sung[3]

1. Chungnam National University

2. Kyoto University

3. National Institute of Forest Science

The purpose of this study was to improve understanding of carbon and nutrient cycling in forests according to alternative forest management. We investigated the effect of thinning and understory vegetation management on litterfall production and fine root biomass at three coniferous plantations, which are *Pinus rigida* (PR), *Abies holophylla* (AH), and *Pinus koraiensis* (PK) plantation. We applied thinning at AH and PK by 50% and 36% of the basal area, respectively, and understory removal at PR. Before and after treatments, litterfall was collected from 1m and 0.5m height litter trap and then was separated into leaves, twig, bark, seed, etc. Eighteen soil cores were taken to estimate fine root biomass by soil depth. Roots were divided into living and dead roots (three diameter classes: 0-1, 1-2, 2-5mm). Our results show that total fine root biomass in PK was 204 g m-2, which is two thirds of that in PR, 296 g m-2. There was a similarity between fine root biomass and litterfall mass. PK, which has little understory vegetation, showed lower fine root biomass and litterfall mass than AH although PK has higher basal area than AH; it may be due to the effect of understory vegetation. We are still observing litterfall and fine root

biomass after thinning and understory vegetation removal. These findings will improve our understanding the role of crop tree and understory vegetation in carbon and nutrient cycling in planted forests.

Email: bbpark@cnu.ac.kr

Ecological restoration through afforestation enhanced ecosystem services: sub-tropic Grain for Green Program

Zheng Ji[1], Liu Yuanqiu[2], Wei Xiaohua[3], Huang Guoxian[2], Zhang Hui[4], Zhang Yangchun[5]
1. School of Agriculture and Biology, Shanghai Jiaotong University, Shanghai 200240, China
2. College of Forestry, Jiangxi Agricultural University, Nanchang 330045, China
3. Earth and Environmental Science, University of British Columbia (Okanagan),Kelowna, BC V1V 1V7, Canada
4. Jiangxi Popularization Center of Forestry Science and Technique, Nanchang 330038, China
5. Afforestation Department of Jiangxi Forestry Department, Nanchang 330038, China

In this paper we present an empirical modelling approach driven by forestry inventory datasets for estimating carbon storage and sequestration potential in the Grain for Green Program in Jiangxi province from 2001 to 2040. The results strongly indicate that the establishment of forest on degraded cropland and barrenland has significantly enhanced the carbon storage and sequestration capacity. The component and total carbon pool sizes varied largely among the five forest types, including *Pinus massoniana, Cunninghamia lanceolata, Pinus elliottii, Liquidambar formosana, Populus simonii*. The carbon storage, net primary production (NPP), net ecosystem production (NEP) and the average total C sequestration rate of *Cunninghamia lanceolata* were far more than other forest types. Our results also reveal that SOC stocks decreased in the initial 6–8 years after land use change and then the soil C pool turned from a source to a sink coincident with vegetation restoration and the C accumulation rates range from -0.03 Mg hm^{-2} yr^{-1} to the highest 0.12 Mg hm^{-2} yr^{-1} in the next 10 years. With the increasing of the stand age, the NEP decreased obviously after the age of 20 years, while the ecosystem carbon sequestration kept increasing. GGP could potentially lead to an average net C increase of 0.8×10-3 Pg C yr^{-1} from 2010 to 2040, equivalent to offsetting 1.77% of Jiangxi province annual carbon emissions in 2009.

Email: zhengjiji456@sjtu.edu.cn

Impact of wild fires on carbon dioxide dynamics and management strategies to enhance its sequestration in *Pinus roxburghii Sarg*. forests

Vipan Guleria[1], Sanjeev Thakur[1], Amol Vashishth[2], Atul Gupta[1]
1. Dr Y S P U HF SOLAN INDIA
2. RAU KOTA (INDIA)

Pinus roxburghii Sarg. dominated forests are the backbone of lower Himalayas and provide a variety of ecosystem goods and services and also act as source to sink atmospheric CO_2, which(CO_2) is on the rise due to various anthropogenic activities. Chir pine is native of Himalayas and covers an area beginning from Afghanistan in the west and ending in Bhutan in the east. Chir pine forest face fire hazard every year, resulting in loss of organic matter and change the physico-chemical and biological properties of soil. Forest biomass of chir pine dominated increased after last wild fire. Similarly, shrubs also added biomass up to 1.12 t/ha after four years

of fire in chir pine dominated forests. Chir pine trees forest added carbon dioxide up to 42.54 Mg/ha during four years after wild fire whereas shrubs added carbon dioxide up to 1.05 Mg/ha during the same period. Perennial grasses biomass and diversity also changed with fire. Soil carbon increased with altitude in pine dominated forests. Whereas, carbon loss from the soil by fire was recorded up to 20.43 Mg/ha. CO_2 capturing can be enhanced by managing the fire causing pine needles. The products like pine peat and chir pine needle embedded tiles and bricks were developed and tested for their utility and stability.

Email: vipanguleria1971@gmail.com

Differential effects of conifer and broadleaf litter inputs on soil organic carbon chemical composition through altered soil microbial community composition

Wang Hui, Liu Shirong
Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

The composition of plant litter and its rate of input to the forest floor will change due to climate, land-use change, and ecosystem disturbance? A strategic selection of tree species will shift the type and quality of litter input, and subsequently magnitude and composition of the soil organic carbon (SOC) through soil microbial community. We conducted a manipulative experiment in randomized block design with leaf litter inputs of four native subtropical tree species in a *Pinus massoniana* plantation in southern China and found that the chemical composition of SOC did not differ significantly among treatments until after 28 months of the experiment. Contrasting leaf litter inputs had significant impacts on the amounts of total microbial, Gram-positive bacterial, and actinomycic PLFAs, but not on the amounts of total bacterial, Gram-negative bacterial, and fungal PLFAs. There were significant differences in alkyl/O-alkyl C in soils among the leaf litter input treatments, but no apparent differences in the proportions of chemical compositions (alkyl, O-alkyl, aromatic, and carbonyl C) in SOC. Soil alkyl/O-alkyl C was significantly related to the amounts of total microbial, and Gram-positive bacterial PLFAs, but not to the chemical compositions of leaf litter. Organic C input from leaf litter materials did not directly contribute to the formation of SOC chemical fractions, whereas soil microbial community could be a main factor influencing the chemical composition of SOC. Our findings suggest that leaf litter input could induce changes in SOC chemical stability if a close-to-nature management is adopted in the subtropical region by substituting coniferous monospecific plantations with the native broadleaved tree species.

Email: wanghui@caf.ac.cn

Altered soil microbial functional groups and enzymes activity contributing to changes of soil carbon chemical composition in mixed N_2-fixing species and Eucalyptus urophylla plantation in subtropical China

Huang Xueman[1,2], Liu Shirong[2], You Yeming[1], Wen Yuanguang[1], Wang Hui[2]
1. College of Forestry, Guangxi University
2. State Forestry Administration's Key Laboratory of Forest Ecology and Environment, Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

Microbial communities and their associated enzyme activities affect the amount andchemical quality of carbon in soil. We aimed to evaluate the biochemical mechanisms underlying how N_2-fixing species influences the soil organic carbon chemical composition through soil microbial functional groups and enzyme activities. We examined the effects of mixing N2-fixing species with Eucalyptus on soil carbon storage and chemical composition of an 8-year-old pure Eucalyptus urophylla plantation (PP) and a mixed E.urophylla and Acacia mangium plantation (MP). The soil carbon stock and recalcitrant carbon chemical component significantly increased in surface soil in MP. The total PLFAs and bacterial PLFAs increased by 29.1% and 27.0% in cool-dry season, Otherwise, in the warm-wet season, the total PLFAs and bacterial PLFAs increased by 13.1% and 27.3%, respectively. However, the fungal PLFAs decreased significantly in warm-wet season in MP. The total activity of the cellulose-degrading enzyme β-glucosidase was significantly greater under mixing with N_2-fixing species in either dry-cool season or wet-warm season. An increase in the Alk-C / O-Alk-C ratio and SOC was associated strongly with both C-acquisition activity and bacterial community. Our findings highlight the importance of N_2-fixing species in regulating both soil microbial communities and their functioning in associationwith soil extracellular enzyme activities, which contribute to the increased soil carbon storage and recalcitrant carbon composition in eucalyptus plantations.

Email: huangxm168168@163.com

Study on spatial distribution of soil carbon storage in mangrove forest of Qinglan harbor

Wen Wanyu, Guo Yanru, Guo Zhihua
Chinese Academy of Forestry

Soils are the major storage of carbon in the terrestrial biosphere. soil organic carbon plays a huge role in greenhouse gas and carbon mitigation projects, and has significant implications for the global carbon cycle. The focus of the present study was the soil in mangrove wetland of Qinglan Harbor mangrove forest in Hainan province. We used multi-point line surveys and laboratory measurement methods in different vegetation community and tidal zone. We analyzed soil carbon storage variation with soil depth,

and studied on the soil carbon storage in 0~100cm deep in different communities types and different tidal zone. The results indicated that: (1) Soil carbon storage presented different characteristics with soil depth increases. The wave crest of carbon storage in soil occurred at the 40~90cm depth, and the range of soil carbon storage was 0.21~2.68 kt/km^2. (2) In high tide level and mid tidal zone, soil carbon storage of the three communities from high to low were *Sonneratia caseolaris*>*Lumnitze raracemosa*>*Sonneratia alba*. (3)The same communities, but different tidal zone, soil carbon storage showed low tidal level> mid tidal level> high tidal level. (4) Mangrove forest was rich in carbon storage in soils, and the organic carbon content was high and deep distribution. The soil carbon storage of Sexangula communities in 0~60cm was more than 20kt/km^2. In this study, the average soil carbon storage in 0~100cm was 25.87kt/km^2.

Email: mangoforlove@163.com

Session D8-03 (42): Forest biodiversity and resilience under changing environmental conditions

Extinction debt in a biodiversity hotspot: the case of Chilean winter rainfall-valdivian forest

Jin kyoung Noh, Cristian Echeverria, Anibal Pauchard
University of Concepcion

Habitat fragmentation has become major research themes because of negative influences on plant species declines and extinctions. However, local extinction of species can occur with a substantial delay following habitat fragmentation, and such delay is called extinction debt. Many studies about extinction debt rely on community equilibrium from relationships between species richness and habitat variables. We assumed that the distribution of many vascular plant species in the Coastal Range of south-central Chile is not in equilibrium with the present habitat distribution. The aim of this research was to detect extinction debt from relationships between current richness of different assemblage of vascular plants (considering longevity and habitat specialization) and both of past and current habitat variables. Results show that native forests have been reduced by 53% in the study area between 1979 and 2011. Current richness of plant species was mostly explained by past area and connectivity. Past habitat variables explained best for richness of long-lived specialist plants, which are characterized by restricted habitat specialization and slower population turnover. We also showed that habitat fragmentation has resulted in a significant reduction in long-lived plant species optimum patch size between 1979 and 2011. Our analyses provide the first evidence of future loss of plant species in South American temperate hotspot. Consequently, an unknown proportion of the plants in the study area would be extinct, if there are no targeted restoration and conservation actions in the near future.

Email: njk1201@hotmail.com

How many broadleaved trees are enough in conifer plantations? The economy of land sharing, land sparing and quantitative targets

Yuichi Yamaura[1,2], Yasushi Shoji[2], Yasushi Mitsuda[3], Hajime Utsugi[1], Takahiro Tsuge[4], Koichi Kuriyama[5], Futoshi Nakamura[2]
1. Forestry and Forest Products Research Institute
2. Hokkaido University
3. University of Miyazaki
4. Konan University
5. Kyoto University

For biodiversity conservation to be an effective and significant social investment, non-marketed values of biodiversity conservation and its associated opportunity costs should be evaluated in monetary terms.

In this study, we measured the willingness to pay (WTP) for bird abundance using a choice experiment (CE) based on the random utility model. We performed a cost–benefit analysis to identify the optimal proportion of broadleaved trees in conifer plantations on a volume basis to maximize the social benefits of bird conservation and wood production.

The results suggested that respondents to the CE were not satisfied with their current situation and preferred an increase in bird abundance. However, the estimated WTP indicated diminishing returns of bird conservation. More specifically, WTP first greatly increased before gradually experiencing decreasing marginal values, reaching its peak and finally decreasing slightly with increasing bird abundance.

Optimization analyses indicated that when the relationship between bird abundance and broadleaved tree proportion was convex, semi-natural plantations with nonzero broadleaved tree proportion (0·02–0·22) were always optimal options. When the relationship was linear, optimal broadleaved tree proportion ranged from 0 to 0·78 and was greatly affected by wood values. When the relationship was concave, there were only two optimal broadleaved tree proportions: a very high proportion (approximately 0·90) and the lowest possible proportion (0). When the convex and concave relationships approached the linear form, comparable benefits could be attained across broad ranges of broadleaved tree proportion both within and across the relationships. In such cases, it would be useful to increase the likelihood of a feasible land-use strategy of either land sparing or land sharing in order to be successful.

It can be difficult to set quantitative targets in biodiversity conservation solely on an ecological basis, and social benefits of biodiversity conservation can create diminishing returns in many situations. The framework we propose shows how to reconcile resource production and biodiversity conservation in the real world.

Email: yamaura@ffpri.affrc.go.jp

Effect of tree species diversity on managed forests resistance to biotic and abiotic disturbances

Herve Jactel[1], Johana Boberg[2], Damien Bonal[1], Eckehard Brockerhoff[3], Bastien Castagneyrol[1], Barry Gardiner[1], Jose Ramon Gonzalez[4], Julia Koricheva[5], Nicolas Meurisse[4]
1. INRA - France
2. SLU - Sweden
3. SCION - New Zealand
4. CTFC - Spain
5. University Royal Holloway London - United Kingdom

It is now widely acknowledged that biodiversity provides many ecosystem services, i.e. the benefits human populations can derive from ecosystem structures and functions. One main ecosystem service category is the regulation of biological conditions which includes ecosystem resistance to pests, pathogens, invasive species, storms, drought and more generally natural disturbances. However most evidence supporting the diversity - resistance hypothesis have been so far documented in grasslands. Here we review the current scientific knowledge about tree species diversity effects on managed forest health in the broadest sense of the term. Based on comparisons between tree monocultures and mixtures we provide an overall estimate of the direction and magnitude of tree diversity effects on forest resistance to biotic and abiotic hazards. We also discuss about potential mechanisms underlying diversity - resistance relationships, including bottom-up processes (tree-tree interactions limiting the likelihood of target trees being hit), top-down processes (e.g. pest or pathogen control by natural enemies) or emerging properties from mixing tree species (e.g. change in leaf traits, crown structure, root traits). Finally we use the outcomes of our review to propose knowledge-based solutions for the establishment of more resistant mixed forest plantations through relevant tree species associations.

Email: herve.jactel@pierroton.inra.fr

Effect of forestry treatments on microclimate, regeneration and biodiversity. An experimental study

Péter Ódor[1], Gergely Boros[1], Zoltán Elek[1,2], Ferenc Samu[3], Flóra Tinya[1], Réka Aszalós[1], András Bidló[4], Péter Csépányi[5], Bence Kovács[1,6]
1. MTA Centre for Ecological Research, Institute of Ecolog and Botany, Vácrátót, Hungary
2. MTA-ELTE-MTM Ecology Research Group, Budapest, Hungary
3. MTA Centre for Agricultural Research, Agricultural Institute, Budapest, Hungary
4. Department of Forest Site Diagnosis and Classification, University of West-Hungary, Sopron, Hungary
5. Pilisi Parkerdő Ltd., Visegrád, Hungary
6. Eötvös Loránd University, Department of Plant Taxonomy, Ecology and Theoretical Biology, Budapest, Hungary

The more frequently used forestry systems providing continuous forest cover (tree selection, group selection) beside the traditional forestry systems (shelterwood, clear-cutting) diversified the useable forestry practices in Central Europe. Investigating the effect of these management types on forest site, tree regeneration and biodiversity is important both for ecological and management purposes.

The effect of five forestry treatments (preparation cutting, gap creation, clear-cutting, retention tree group and control) was studied in a mature temperate sessile oak – hornbeam forest in Hungary on microclimate, soil, regeneration and biodiversity of plants, ground beetles, spiders and enchytraeid worms. The experiment was carried out in 2014, this presentation summarize the preliminary short-term responses.

Air and soil temperature were highest in the clear-cuts, but retention tree groups had very similar thermal pattern. The increase of soil water content in connection with tree-removal was the highest in the gaps, while it is also detectable in the clear-cuts. The abundance of enchytraeid worms significantly decreased in clear-cuts and retention tree groups and their composition also changed. A similar significant compositional alteration was observed for ground beetles and spiders. An implanted epixylic bryophyte species (*Lophocolea heterophylla*) showed the highest survival rate in control plots, conversely in clear-cuts, the extinction was very fast. For plants, the processes were relatively slow, their dominance relations did not change considerably after two years of the treatment. Based on this short observation period we can conclude that fine scaled timber production like gap creation or irregular thinning had only moderate effect on forest site, and could maintain the forest biodiversity adapted to shaded conditions.

Email: odor.peter@okologia.mta.hu

Short-term manipulations of rainfall and nitrogen had minor effects on activity density and species diversity of carabid beetles within a temperate forest

Wang Xiaowei, An Linli, Han Shijie, Ji Lanzhu
Institute of Applied Ecology, Chinese Academy of Sciences

Global changes in precipitation and regional increases in atmospheric nitrogen (N) deposition are predicted to alter soil and vegetation systems, which in turn may affect the abundance and diversity of insects. The present study (started in July 2009) simulated increasing (+33%) and decreasing (-33%) rainfall as well as ambient and increased N (+ 50 kg N ha^{-1} yr^{-1}) scenarios in an old-growth, temperate forest. We examined how these environmental manipulations affected the activity density and species richness of carabid beetles (Coleoptera: Carabidae) across the different treatments. Carabid beetles were collected with pitfall traps during an entire year (July 2010 to July 2011). We did not find strong N effects on activity density of carabid beetles. However, we detected an overall weak, negative effect of rainfall addition on their activity density by using both the treatment-based (ANOVA) and the spatially explicit (SADIE) approaches. Neither changes in rainfall nor N affected the number of carabid species. Therefore, the two-year rainfall and N manipulations had generally minor effects on carabid beetles. Given the highly mobile trait of many carabid species, we argued that the short-term trend (an aversion of the carabids to high rainfall plots) found did not necessarily represent changes in carabid populations as might happen due to changes in the environment, but instead are a result of dispersal and redistribution of carabid individuals.

Email: wangxw@iae.ac.cn

Relative importance of tree species and genetic diversity for above-and belowground processes in a boreal forest

Sandra Barantal
Royal Holloway University of London

Extensive research over the last decades have confirmed that ecosystem functioning generally declines as species richness is reduced. While most of previous studies focused on the effects of plant species richness, the effects of others components of biodiversity such as intraspecific diversity are less investigated, especially in forest ecosystems. Here, we examined the relative effects of tree inter- and intraspecific diversity on herbivory and soil processes using two comparable long-term forest diversity experiments established in boreal forests of SW Finland in 1999-2000. The tree species diversity experiment manipulates from 1 to 5 tree species planted per plot and the genetic experiment manipulates from 1 to 8 silver birch genotypes per plot. The microbial respiration, microbial biomass, soil microbial functional diversity and the decomposition of a standard material have been measured as well as the insect herbivore damage. Using these data, we tested the hypotheses that 1) insect herbivore damage on birch decreases with an increasing species and genetic diversity 2) both genetic and species diversity promote microbial processes 3) the effects of interspecific diversity are stronger than intraspecific diversity effects. Understanding the relative role of genetic and species diversity is important to know to what extent conservation and management efforts have to be focused on species richness vs. intraspecific diversity.

Email: sandra.barantal@rhul.ac.uk

Evaluating the effect of retention forestry in planted forests

Kenichi Ozaki[1], Yuichi Yamaura[1], Nobuhiro Akashi[2], Akira Unno[2], Toshiyuki Tsushima[2], Yuu Nagasaka[2], Akiko Nagasaka[2], Naoki Inari[3], Katsuhiko Sayama[3], Shigeho Sato[3]
1. Forestry and Forest Research Institute
2. Hokkaido Research Organization, Forestry Research Institute
3. Hokkaido Research Center, Forestry and Forest Products Research Institute

Ongoing global expansion of planted forests increases the need to develop silvicultural practices that conserve biodiversity in planted forests. Retention forestry, the practice of intentionally leaving important forest structure and organisms within logged areas, is increasingly implemented as an alternative to clear cut harvesting. Retention forestry has been tested for more than two decades and its potential as a conservation tool has been demonstrated globally. However, there is little empirical information available for applying retention forestry in planted forests. We initiated a large-scale experiment (REFRESH) in 2013 to evaluate retention forestry in planted forests in Hokkaido, northern Japan. The aim of the experiment is to establish a forest management system that balance the ecological, social and economic values of planted forests. The REFRESH study is carried out in native fir (Abies sachalinensis) plantations and involves eight treatments including aggregated and dispersed retention. Each treatment is replicated in three blocks (5-9ha each). In dispersed retention, naturally regenerated broad-leaved trees are retained in three levels (10, 50, 100 stems per ha) to restore structures and elements of original natural forests in the region. we provide an overview of the experimental design, the scope of scientific inquiry and initial findings from the experiment.

Email: ozaki@affrc.go.jp

Session D8-03 (95): Nature-based solutions to climate change mitigation and adaptation.

Climate change mitigation and adaptation by urban forests – an example from Vienna

David Neil Bird[1], Hannes Schwaiger[1], Heinz Gallaun[1], Maja Zuvela-Aloise[2], Konrad Andre[2]
1. JOANNEUM RESEARCH Forschungsgesellschaft mbH, Graz, Austria
2. ZAMG - Zentralanstalt für Meteorologie und Geodynamik, Vienna, Austria

In urban areas, solar energy is absorbed and stored more than in rural landscapes. This is mainly due to the colour and aspect of urban surfaces such as rooftops, streets, parking spaces for cars and other built-up areas and the higher heat storage capacity of urban materials as compared to the rural landscape. The mitigation of the problem that results, the urban heat island (UHI), is the driver for various urban development measures such as greening of façades and roofs, and the expansion of parks and lawn. Climate change is modelled to exacerbate UHIs and, at the same time, city texture is thought to exacerbate climate change (positive-feedback) since:

(a) increased warming of urban areas especially in the summer months will increase the demand for space cooling of apartments, office buildings and houses. The electrical energy required may come fossil fuel fired power plants and hence cause greenhouse gas emissions (GHGs) indirectly; and

(b) increased albedo as compared to rural areas also increases the solar energy absorption due to reduced reflection and is equivalent to increased GHG emission warming potential.

Although adaptation measures to reduce summer temperatures in cities are often considered for low-latitude cities, air conditioning use has increased in recent years in Austria and the energy demand for space cooling and ventilation is expected to grow strongly with climate change. The increased intensity and frequency of heat waves in the summer months could thereby have far-reaching consequences in terms of the climate, energy consumption, health and quality of life.

The aim of this exploratory project was to investigate different concepts for reducing urban heat islands (UHIs), and to assess the energy and greenhouse gas emissions savings that may result from a cooler city microclimate. In particular, the impacts of modifying the albedo of roofs, roads, parking areas, and green roofs on the microclimate of the City of Vienna were modelled and the potential reduction in energy use and GHGs were estimated.

The project found that a comprehensive application of highly reflective roofs (albedo = 70%) in combination with the full implementation of green roofs can lead to a strong decrease in the number of hot days (days with Tmax > 30°C). In comparison to the period 1981 – 2010, the number of hot days in the inner city and near inner-city may be reduced by up to 29% and 20% respectively. Model calculations show that the "theoretical potential" can be achieved by including highly reflective facades to buildings and sealed surfaces. In this case, the number of hot days may be reduced in the inner city by up to 53%. This leads to an electricity saving potential of 5,000 - 20,000 MWh per year - at current cooling capacity and indirectly decreases GHGs by 600 – 2,000 t CO_2 /year. However, there is a greater reduction in equivalent GHGs directly due to the decrease in radiative forcing caused by changing the roof albedo. The decreased radiative forcing is comparable to additional savings of around 75,000 t CO_2 / year. Additional effects regarding human comfort and other positive aspects in terms of human health should be considered as well. There are many areas for future research on this theme.

Email: neil.bird@joanneum.at

Carbon forestry practices with co-benefits of community and biodiversity adaptation: practices in Inner Mongolia

Zhao Quansheng
Inner Mongolia Hesheng Ecological Silviculture Co. Ltd.

Inner Mongolia covers a vast geographic area, crossing the three-north areas, has an important geographic position. In "Two barriers & three belts" ecological security pattern of China, Inner Mongolia is an important ecological barrier of northern China, and block the sand storm from south China. Meanwhile, this region located in transitional zone from agriculture to husbandry and the ecological environment is fragile. Due to over grazing and over farming, plus climate change, the environment was destroyed. Therefore, to restore and conserve the ecosystem in arid and semi-arid areas and to increase the afforestation areas in Inner Mongolia is the guarantee for the sustainable development.

In 2010, Inner Mongolia Shengle International Ecological Demonstrated Area Project was initiated and by Laoniu Foundation, The Nature Conservancy, China Green Carbon Foudation, and Inner Mongolia Forestry Department. Inner Mongolia Hesheng Ecological Silviculture Co. Ltd. is in charge of implementation and maintenance.

Hesheng has been committed to exploring the ecological restoration, aims to being the lead enterprise on barren mountains restoration, focused on climate adaptation, vegetation restoration, water management and biomass energy. After 4-year practice 2500 ha degraded land was restored by means of vegetation. The local community participated in the vegetation restoration and maintenance, and will gain the forest and affiliated profit after the project completed in 30 years. Meanwhile, in order to guarantee the sustainable development of restored land, Hesheng explored the model of enterprise promoting farmers, developing ecological breeding and farming, shrub land management at the project site to increase the income of the community. The model became a scientific example for the ecological restoration in arid and semi-arid areas. According to the international forest carbon standard, the project was accomplished and gained the carbon credit, and got the CCB Gold certification, which was the third in China.

Email: wlongzhu@tnc.org

Impact assessment of climate change on biodiversity priority conservation areas and adaptation strategy recommendation in China

Wang Longzhu
The Nature Conservancy

Globally climate change and its adverse impacts have become a common concern for the entire human race. In the most recent 50 years, climate change of higher temperature has produced a significant effect on global natural ecosystems, which is a critical threat to biodiversity universally acknowledged. Under the pressure of climate change in the next 50 or 100 years, the questions tend to be what climate change would influence China's biodiversity priority conservation areas (PCAs), and how to effectively protect precious biodiversity in the PCAs.

To answer these questions, an integrated impact assessment to climate change is conducted in the 32 PCAs at national level. The impact of climate change in biodiversity is analyzed in each specific PCA, the 32 PCAs are prioritized according to vulnerability, and adaptation strategies are provided corresponding to the impacts, all of which concreted the scientific base for enacting climate adaptation policy.

On the climate change vulnerability analysis, IPCC (Intergovernmental Panel on Climate Change)'s assessment method is adopted. The three indexes including exposure, sensitivity and adaptation capacity are assessed in each PCA. It's found that South Hengduan Mountainous Area and Minshan-North Hengduan Moutainous Area would be very sensitively response to climate change, and they are in addition of dramatic exposure and vegetation change in the next-50 and 100 years, as a result of that, the two regions tend to be the first class affected by climate change of the highest sensitivity. It is noticeable that various endangered specific species are widely distributed among those two regions, which inhabit in complex landforms relying on relatively sensitive ecosystems. Additionally, local species and ecosystems are sensitive to climate change. This means South Hengduan Mountainous Area and Minshan-North Hengduan Moutainous Area have the priority to engage climate change adaptation initiatives. Considering the biodiversity characters and climate change impact of these two PCAs, the nature reserves boundaries within these two PCAs and the PCAs' boundaries could be adjusted to response the conservation objectives' distribution change under climate change. The climate change impact monitoring on the species' mitigation and phenology change in some suitable pilot area should be conducted. And adaptation management demonstration also could be conducted in these pilot areas. The ecological payment mechanism could be implemented in these PCAs to guarantee the adequate conservation fund. Aim at the endangered species, which are climate change sensitive and exposed in the risk of habitat loss in these PCAs, the specific climate adaptation conservation plan could be formulated. In order to contain the rapid decrease trend of biodiversity in these PCAs, the local biodiversity conservation laws and regulations could be improved as soon as possible, so as to regular the human activities with the government's guidance and supervision.

Email: wlongzhu@tnc.org

Managing for resilience: adapting traditional forest management to enhance forest health in the Central Appalachians (U.S.) and Southwest China

Scott Bearer, Mark Anderson
The Nature Conservancy

The Nature Conservancy (TNC) has developed a functional dataset, commonly known as the 'TNC Resilience Project', which allows managers to characterize the resilience of habitats across the landscape based on combined measures of complexity and connectedness. Datasets have been completed throughout much of the U.S. and China. While the data have a variety of useful applications, such as prioritization and conservation, they were not meant to suggest appropriate management actions that might enhance resilience. In recent years, however, TNC and others have developed new theories in forest and habitat management that provide the opportunity to downscale these spatial models to a possible suite of management options that may help increase the resilience and adaptive capacity of our hardwood forests commonly found in the eastern U.S. and southwest China. Here, we provide a summary of these recommended management options that enhance resilience. We also discuss how we are integrating these techniques into a multi-partner, landscape-level habitat management collaboration. This collaboration is currently working to enhance resilience and adaptation along the Central Appalachian mountains in the eastern U.S, and we hope the success of the partnership will allow us to develop additional cross-boundary projects in other targeted landscapes.

Email: sbearer@tnc.org

Connecting to our water sources: nature-based solutions to water security

Kari Vigerstol

Nature holds great potential to help provide clean, reliable water for our growing cities, serving a critical role in building climate resilient communities. However, as land is degraded and converted for human use, we lose the ability for nature to filter, infiltrate and store water and we must rely on costly built infrastructure and with ongoing maintenance and operation costs to deliver sufficient, clean water. Roughly half of China's water pollution comes from land use and degradation, especially fertilizers, pesticides, and livestock waste carried into lakes, rivers, wetlands and coastal waters. The pollution is also carried into underground aquifers by rainfall and snowmelt. We have an opportunity to reverse this trend by investing in the watersheds on which we depend for our water sources through conservation activities and improved land management. The Urban Water Blueprint China explores this potential in China by analyzing the return on investment of conservation investments in the source watersheds of the thirty fastest growing cities. The good news is that by targeting conservation strategies to a cumulative area of roughly 1.4 million hectares sediment and nutrient pollution could be measurably reduced – by at least 10 percent – in small and medium sized water sources serving China's largest and fastest growing cities. While large, this area represents less than 3 percent of the area of water sources. Additionally, for half of China's largest and fastest growing cities a savings in water treatment could offset a significant portion of the catchment conservation costs. These nature-based solutions can not only reduce the cost of delivering clean water to our cities, but they can provide a suite of other cobenefits such as carbon mitigation, climate adaptation, and ecological and human health benefits.

Email: kvigerstol@tnc.org

Ecological restoration plan of Horinger in Inner Mongolia

Lei Yongsheng
Lao Niu Foundation

Inner Mongolia Autonomous Region is located in the frontier of northern China, which guarantees Chinese ecological safety as an important barrier. However, due to climate change and human disturbance in the last century, vegetation here has been dramatic declines. This once important ecological barrier is now increasingly fragile and impaired. Desertification, water shortages, drought and loss of biodiversity are all major threats facing both conservation and development throughout Inner Mongolia.

Therefore, Laoniu Foundation , The Nature Conservancy, and the other local partners initiated the Inner Mongolia Ecological Restoration and Conservation Project in August 2010. The project aims to create an ecological restoration plan for the arid and semi-arid areas of Inner Mongolia, and develop a model of the equilibrium between ecological restoration and economic development.

Identify important ecological services, ecological zoning, identify key eco-systems for every ecological zone, identify the significant ecological service areas, distinguish the areas that need to be conserved and restored and so on, through all the process step by step, we will find a scientific way to develop restoration and protection strategies for these conservation and restoration areas. Consequently, our strategies help to influence the decisions of local leaders concerning the distribution of ecological restoration and protection programs.

Email: lnflkq@163.com

Session D8-04 (43): Managing invertebrate diversity for forest function and resilience

Density and diversity of insects that visit cashew (*Anacardium Occidentale* L.) plants in the flowring and fruiting periods in Northern Ghana

Florence Sumala-ang Kuukyi
Ga South Municipal Assembly

Information gap exist on insects that visit cashew during the flowering and the fruiting season in Ghana. Field survey was conducted in ten farms in Northern Ghana, to access the insects distribution during the flowering and the fruiting periods of cashew. The sample farms were divided into four plots measuring 20 m x 25 m in farms close to natural forest and farms away from the forest. Insects found on the cashew farms during the flowering and fruiting periods were identified, counted and unidentified insects were killed in killing jars and preserved in 70% alcohol for further identification. Total insects encountered during flowering in farm close 6161, (SD = 250.7, N = 40), diversity was 3.34. In farms away from the forest, total insect 2745, (SD = 103.2, N = 40), diversity was 3.56. During the fruiting period in farms close to forest, total insects 4665, (SD = 143.5, N = 40), diversity of 3.13. In farms away from the forest, total insects 2056, (SD = 52.1, N = 40), diversity was also 3.14. Insect density and diversity differs in farms close to forest and away from forest during the flowering and the fruiting period.

Email: fskuukyi@gmail.com

A microhabitat assessment for conservation planning of soil mite diversity

Kimiko Okabe, Motohiro Hasegawa
Forestry and Forest Products Research Institute

Most soil organisms live in the surface layer containing organic materials. Although there are numbers of microhabitats such as dead leaves and branches and dead animal bodies in the layer, those materials are not necessarily sampled for faunal survey of so-called soil mites. In order to investigate potential importance of microhabitats for them, we compared mite species compositions in soil and mushrooms in the same sampling sites – 7 different secondary deciduous stands -. 284 species of soil mites were conventionally sampled: mites were collected from soil core samples from 8 quadrats per site using the Tullgren funnel. 68 species of mushroom mites were collected from mushrooms sampled by the line-transect sampling, under a stereomicroscope in a laboratory. The species composition of soil mites showed significant difference from that of mushroom mites in each stand. Furthermore, species compositions of soil mites between sites were less different than those of mushroom mites. Thus, our results suggest that without careful consideration of microhabitats, organisms in the same taxa may lead different conservation strategies – natural forest or not for soil mites but structure/ biomass/ microclimate in natural forests for mushroom mites .

Email: kimikook@ffpri.affrc.go.jp

Recovery of a boreal carabid fauna ten years after variable retention harvest

John Spence
University of Alberta

Carabid beetles are a widely employed to assess responses of biodiversity to disturbance and monitor post-disturbance recovery of the invertebrate fauna. This taxon has been used for testing hypotheses about variable retention harvest on biodiversity in four common boreal mixedwood carabid habitats in the EMEND (Ecosystem Management Emulating Natural Disturbance) experiment in NW Alberta, Canada. We compare impacts of several levels of retention harvest (10, 20, 50 and 75%) with the standard Canadian clear-cut (c. 2% retention) and unharvested controls. Results from the first 10 years show that cumulative activity of c. 35 carabid species, including most forest specialists, was little affected (or actually increased) immediately after harvest, but then fell as populations of most forest species decreased. Despite influx of a number of species that significantly indicate more open habitat, carabid activity remained low ten years post-harvest. Impact on composition of local assemblages was directly proportional to harvest intensity, and recovery of species composition toward that of unharvested controls varied inversely with harvest intensity. Species of late-successional spruce-dominated stands (e.g., Calathus advena, Pterostichus brevicornis) have not recovered toward the reference (or target condition), as defined by either pre-harvest data or 10-ha unharvested control blocks. However, populations of species significantly indicating early successional poplar-dominated stands (e.g., Agonum retractum, Platynus decentis) show better recovery. Carabids and other epigaeic species usefully contribute to measurement of biodiversity as a criterion for assessment of the sustainability of forest management approaches.

Email: jspence@ualberta.ca

Structural elements and saproxylic beetle diversity of mature managed boreal forests

Matti Koivula[1], Jari Jokela[1], Juha Siitonen[2]
1. University of Eastern Finland
2. Natural Resources Institute of Finland

As a result of intensive forestry over several decades in Fennoscandia, certain structural elements – most notably dead wood – have become scarce in most forests in this region. Studies done in old-growth forests have shown that these elements are crucial for hundreds of species. An inevitable conclusion is that such legacies should be increased in managed forests, yet very little is known as to which elements currently determine the species diversity in this environment. We therefore sampled saproxylic beetles in 21 mature managed spruce forest stands in Southern Finland, and analyzed the variation in species richness relative to measures of stand structure (species, size and density of live and dead trees of different species). We detected remarkable variation in the richness of these beetles (41-86 species per stand). According to a multimodel inference approach, this variation was associated with the amount and diversity of stand structures. We suggest that the richness of saproxylic beetles increases with higher amount of dead wood, larger tree individuals, and tree-species mixtures. From a management point of view, we therefore recommend to retain as much as possible of these legacies in harvesting operations.

Email: matti.koivula@uef.fi

Prescribed fire as a tool for forest arthropod management and conservation in subtropical forests

Kamal Gandhi
University of Georgia

Fire is a critical component of many forested ecosystems across the world where it occurs at various severities, intensities, and frequencies. Arthropod populations and communities are invariably affected by patterns and processes created by wildfires. Prescribed fire is widely used as a surrogate for wildfires especially in the pine forests of southeastern U.S. where low intensity understory fires occur at 1-3 year intervals. If conducted properly, prescribed fire achieves multiple objectives including improving wildlife habitat and tree health, maintaining endangered especially pyrophilous species, and promoting specific stand structure and function. Under fire suppression, different sets of communities emerge with little congruence with the fire-adapted ecosystems. As such, the resilience of fire-adapted ecosystem is affected and restoration of these habitats could become a major challenge. I will discuss the pros and cons of using prescribed fire as a tool for management and conservation of subtropical pine habitats along with those of arthropod guilds and trophic levels.

Email: kjgandhi@uga.edu

The role of habitat heterogeneity in determining arthropod diversity in boreal forests across spatial scales

Anne Oxbrough[1], Sergio Garcia-Tejero[1], John OHalloran[2], John Spence[3]
1. Edge HIll University
2. University College Cork
3. University of Alberta

Forest resources can be managed in a way that preserves ecological processes and biodiversity; however, this requires knowledge of disturbance and management impacts at multiple spatial scales. We determine how habitat heterogeneity and arthropod beta diversity are structured across spatial scales ranging from large (1600 to 8500m) to medium (100 to 400m) and small (20 to 40m) in mature and 12 year old regenerating stands in the boreal mixedwoods of Alberta, Canada. Ground-dwelling Araneae and Coleoptera (Carabidae, Staphylinidae) were used as model organisms.

Clear-cutting alters the structure of habitat heterogeneity and beta diversity across spatial scales, leading to both a more homogenous environment and faunal composition. Partitioning of beta diversity reflected major patterns in habitat heterogeneity: at the landscape scale differences among forest cover types contributed more to beta diversity in mature than in regenerating forests. For Araneae, however, pre-felling canopy forest cover type also determined beta diversity in regenerating stands, highlighting the importance of identifying biological legacies in early successional stages. In all arthropod groups, the small scale contributed > 50% of the beta diversity. Only at larger scales was habitat heterogeneity a useful predictor of beta diversity, with forest type a coarse proxy for arthropod species composition.

Email: anne.oxbrough@edgehill.ac.uk

Session D8-04 (96): Dynamics of radiocesium and its influence on forest ecosystem and forestry - the future direction

Heterogeneity of radiocesium contamination in woods

Satoshi Sakurai, Hirohisa Yoshida
Graduate School of Urban Environmental Science, Tokyo Metropolitan University

Radiocesium contamination of trees due to Fukushima Dai-ichi Nuclear Power Plant accident have been investigated by damaging all or part of trees, such as felling or sampling an increment borer. However, in order to observe the radiocesium transfer dynamics in standing trees for a long period, the establishment of a non-damaging sampling method is required. We used D-shuttle dosimeter (Chiyoda Technol Co., Tokyo, Japan) with a semiconductor detector, which was used for personal dose management. D-shuttle dosimeters were setting on a Japanese cedar (*Cryptomeria japonica*) stem at the heights of 0.5 m, 1.0 m, 2.0 m above ground and also on a cedar root at the heights of -0.2m below ground in Kawamata town, Fukushima prefecture. To prevent the disturbance of ambient dose, the dosimeters were covered with a lead block with thickness about 3 cm except for the tree side. Measured values implied the sum of dose rate of four factors: the outer bark, the ground surface following the distance from ground, the ambient and the wood including the inner bark. Hence the shielding effect of the lead block could be limited. The result suggested that the relative dose of cedar considered to increase from summer to late fall.

Email: s.skr03@gmail.com

Utilization of 137Cs-contaminated wood by kraft pulping process

Wei Wang, Dan Aoki, Yasuyuki Matsushita, Kazuhiko Fukushima,
Chisato Takenaka, Rie Tomioka
Graduate School of Bioagricultural Sciences, Nagoya University

Forests in Fukushima Prefecture were heavily polluted by radiocesium as a result of Fukushima Daiichi Nuclear Power Plant accident, which retarded the utilization of woody biomass. The purpose of present study is to evaluate the possibility of utilization of 137Cs-contaminated wood by kraft pulping process. To simulate the 137Cs-contaminated wood, we prepared 133Cs-contaminated woods by applying 133CsCl aqueous solution to bark of Japanese cedar (133Cs was then absorbed by bark and entered wood). Wood chips were prepared and digested by kraft pulping process. After the digesting, the pulp was washed with ultra-pure water and separated from black liquor. The obtained black liquor was acidified with 10% sulfuric acid to precipitate acid-insoluble lignin. 133Cs concentration in each component was evaluated by ICP-MS. Results showed that about 99.3% of 133Cs was present in supernatant of black liquor, while only a minor part was found in pulp (0.60%) and lignin (0.097%). These results indicated that utilization of 137Cs-contaminated wood is possible through kraft pulping process.

Email: wwcy1219@gmail.com

Consequences of radiation disaster by a nuclear accident for people living on forest products

Satoru Miura
Forestry and Forest Products Research Institute

This paper discusses consequences of radiation disaster by a nuclear power plant accident for people earning a livelihood from forest products. I intend to drive people concerned about forestry to take precautionary measures for radioactive damages for future unexpected disasters. First, I introduce the overview of actual conditions of radiation disaster experiences in forests and forestry by Fukushima Daiichi Nuclear Power Plant (FDNPP) in 2011. Cs-137 is the radionuclide that has brought the most profound and long-lasting impact to forestry. Several monitoring studies revealed that Cs-137 widely spread over forested area would be remained for long time within forest ecosystems, mainly in the surface layers of soils. Forestry dealing man-made conifer trees for timber had been affected by limited impacts from radiation contamination. However, mushroom log producers those had been one of the major forestry activity neighboring FDNPP suffered seriously. Severity of the impacts of radiation contamination depended upon how people had utilized forest products in the region. Creating prompt and effective measures for rehabilitation from radiation disaster in forestry requires collaborative work among natural and social sciences.

Email: miura@ffpri.affrc.go.jp

Change of radiocesium contamination in the forests for five years after the Fukushima Daiichi nuclear power plant accident

Shinji Kaneko
Forestry Forest Products Research Institute

Due to Fukushima Daiichi Nuclear Power Plant accident in March 2011, radiocesium ($Cs^{-}134+Cs^{-}137$: rCs) deposition widely occurred in the forests in eastern Japan. In order to understand the status of contamination, Forestry and Forest Product Research Institute set up monitoring plots in the forests under different contamination level in the summer of 2011, and monitored radiocesium contamination of each part of forest ecosystem for five years. The first year's survey showed that more RCs were caught by the canopy of ever-green conifer forest than that of deciduous broad-leaved forest. The every year survey demonstrated that the total activities of rCs have considerably decreased mainly due to physical decay, most rCs immediately transferred to the forest floor from the canopy due to rain washing and litterfall, and more than 90% of rCs were remained in the organic layer and the mineral surface soil in the summer of 2015. The rCs dynamic in the forest is generally same to that after the Chernobyl accident but the transfer speed might be faster in Fukushima's case.

Email: kanekos@affrc.go.jp

The characteristic of radioactive cesium absorption by wood chip installed on forest floor

Terumasa Takahashi, Tatsuaki Kobayashi
Chiba University

The purpose of this study is to clarify the characteristics of radioactive cesium absorption by fungi multiplied in wood chips installed on forest floor. The study site is located in radioactive cesium contaminated deciduous broad-leaved forest established on slope in Fukushima, Japan. In July 2013, Japanese cedar (*Criptomeria japonica*) trees in the site were cut down and were crushed into wood chip. We set three plots in upper, middle and lower slope of the site, and installed 3 - 5 kg m^{-2} of the wood chips on forest floor after removing Oi horizon in each plots. We collected the wood chips every one – six months and sorted them by particle size and investigated wood chip decomposition rate and radioactive cesium concentration of the wood chips every particle size and calculated amount of absorbed radioactive cesium. The smaller particle size of wood chip, the higher radioactive cesium concentrations were obtained. 15 - 21 kBq m^{-2} of radioactive cesium were absorbed in wood chips for one year and were equivalent to 4 - 5 % of amounts of radioactive cesium in Oe, Oa and mineral soil horizon before wood chip installation.

Email: teru@faculty.chiba-u.jp

The effects of the removal treatment of organic horizon on the stock and flux of radiocesium in the secondary Quercus-Pinus forest

Tatsuaki Kobayashi, Hiroki Furihata, Rie Yamamoto, Sho Saitoh, Masaki Endoh, Takamasa Hirano, Hiroyuki Suzuki, Terumasa Takahashi
Chiba University

The response of forest ecosystem to the remediation work against the contamination of radiocesium by the accident of Fukushima Daiichi NPP was monitored for three years. All of the following data was half-time corrected to March 15, 2011. The initial deposition of 137Cs was 500kBq/m^2, and 94% of it was located at the forest floor in 2015. The supply of 137Cs from canopy to forest floor was decreased from 7kBq/m^2 in 2013 to 4.4kBq/m^2 in 2014, but it was increased to 4.7 kBq/m^2 in 2015. It suggests that the phase of 137Cs dynamics is changing from the dynamic state to the equilibrium state. Runoff of 137Cs has stayed less than 0.4kBq/m^2 for 3 years. The stock of 137Cs in the forest floor was reduced for 79% due to the removal of whole organic horizon and for 43% due to the removal of fresh litter. The supply of 137Cs from canopy to forest floor was reduced for 38% and 33%, respectively. The effect of treatment was observed in the flux of 137Cs, however, it was not correlated with the strength of treatment. The removal of lower layer of organic horizon might not affect the reduction of available radiocesium, because the clay in its layer fixed radiocesium firmly.

Email: ktatsu@faculty.chiba-u.jp

Session D8-05 (66): Enhancing connections between forest ecology and management

Insights into management from forest ecology

Jean-Paul Laclau
CIRAD

Comprehensive studies of forest ecology improve our understanding of how forest ecosystems function and our ability to design sustainable silvicultural practices that maximize the ecosystem services provided by forest ecosystems. Three case studies are presented to show sustainable management practices derived from studies dealing with forest ecology. In tropical regions, large amounts of fertilizers are needed to sustain the productivity of eucalypt plantations. Improved understanding of rooting patterns in deep soil layers as well as the nutrient demands of trees and the geochemical processes controlling the fluxes of nutrients in gravitational soil solutions made it possible to reduce the cost of fertilization at large scale in Brazil by refining the timing of application needed. In coastal rainforests of British Columbia, ecological studies of old-growth forests elucidated the proximate and ultimate causes of growth check and poor nutrient supply in regenerating forests. As a result, silvicultural interventions can be focused on the causes rather than the symptoms of the regeneration problem. In temperate forests of North America, ecologists have demonstrated the importance of early successional forest habitat for sustaining biodiversity, while also incorporating legacy structures that provide habitat for other species.

Email: laclau@cirad.fr

Insights into forest ecology from management

Dan Binkley[1], Mark Adams[2], Harri Mäkinen[3]
1. Northern Arizona University
2. University of Sydney
3. Finnish Forest Research Institute

Forest management activities have altered many forests around the world, shifting forest structure, species composition, and growth rates. The scale of these operations can enhance our scientific understanding of forest ecology. We explore this perspective with three case studies. 1) Monitoring of forest growth in thousands of plots across Finland revealed that forest growth more than doubled in the past 60 years. The scale of the sampling allowed strong tests of contributing factors, and warming climate accounted for about one-third of the increased growth. 2) The influence of forest structure on the severity of uncontrollable wildfires was evident from landscapes in both Australia and the United States. Managed forests were less likely to burn, and to burn at lower intensity, than unmanaged forests. 3) The connections between management and ecology can be enhanced with a blended, “pocket science” approach where management-scale activities include simple treatments that provide opportunities to learn. Routine inventory plots in Brazil were paired with simple fertilization plots to explore nutrient limitations across gradients in soil and climate, improving silvicultural operations. Scientific understanding for large populations of inference may be strongest when based on information derived from large areas.

Email: dan.binkley@alumni.ubc.ca

Reciprocal implications between forest ecology and management practices: case studies from East Asia

Yowhan Son, Seongjun Kim
Korea University

As management strategies closely depend on the understanding of forest ecosystems, forest ecology and management practices indubitably interact with each other. This presentation aims to convey insightful case studies from East Asia. Some cases illustrate that extensive management practices could re-shape the structure and function of forests, and consequently improve our knowledge on forest ecology. National reforestation programs in South Korea since 1960s exhibits that large-scale forest rehabilitation has changed the regional ecosystem functions such as the carbon balance and biodiversity. In China, forest fire managements to the Greater Khingan Mountains after 1987 demonstrate that fire suppression and restoration have altered the landscape and the regional fire regime. Meanwhile, other cases show reciprocal implications of forest ecology into establishing the management practices. Efforts for controlling the pine wilt disease in Japan are relevant to denote how typical researches have influenced the forest management strategies. Comparisons of natural forests with managed forests in the Gwangneung experimental site reveal how long-term ecological monitoring has led to the improved practices in managing water and nutrient resources, carbon sequestration, and biodiversity. Also, other long-term ecological researches across the East Asian countries have accompanied the advances in management practices and rehabilitation guidelines.

Email: yson@korea.ac.kr

Improving silvicultural systems of loblolly pine plantations for carbon sequestration and biomass production

Dehai Zhao
University of Georgia

Pine plantations in the southern US have been among the most intensively managed forests in the world, and the productivity has tripled over natural pine forests. As we are trying to increase carbon (C) sequestration further enhancing pine plantation productivity by refinement to silvicultural regimes, whether the maximum productivity or the maximum potential C sequestration exists remains unclear. Meta-analysis of six, long-term well-designed field trials across the geographic range of loblolly pine (Pinus taeda L.) indicated that a maximum productivity and a maximum response to silvicultural practices which is inversely proportional to the base site quality to evaluate the site index response in relation to the base site quality. An analysis of an extensive study involving different levels of silvicultural inputs and planting densities in loblolly pine plantations demonstrated that the effects of planting density and cultural intensity on biomass production strongly interacted with site quality. The results highlight that we should adopt a new silviculture, one of variable silvicultural intensity depending on the site quality.

Email: zhaod@uga.edu

Degraded shelter forest restoration policy in China

Wang Yafei, He Youjun
Research Institute of Forestry Policy and Information, Chinese Academy of Forestry

Shelterbelt forestation is an important part of China's ecological establishment. However, due to multiple reasons, shelter forest in China shows a degradation in large areas, and some parts witnessed a serious degradation. According to the Eighth forest resource inventory, China now has 99.67 million hectares of protection forest, accounting for 48% of forest land area. Degraded shelter forests in Northwest, North and Northeast of China (also called “Sanbei”in Chinese) account for 15% of total area of shelter forests.

At present, various kinds of artificial shelter forests in China have gradually entered their maturation period and overmature period, thus increasingly suffering from aging and declining. Besides, due to the constraint of our social economic development and technological level at that time, these shelter forests are beset by such problems as single forestation species, simple structures, unreasonable density and poor stand growth status. With serious influence of climate change and natural disasters, the functions of these shelter forests are decreasing. This paper has analyzed problems in China's policies and management of restoring degraded shelter forests while discussing possible policies and suggestions for further improvement in this regard.

Email: mylenewang@163.com

Divergent tree growth response to recent climate warming of Abies faxoniana at alpine treelines in east edge of Tibet Plateau

Zhang Yuandong[1], Guo Mingming[2], Wang Xiaochun[3], Gu Fengxue[4], Liu Shirong[1]
1 Key Laboratory of Forest Ecology and Environment, State Forestry Administration, Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

2 Key Laboratory of Bamboo and Rattan, International Centre for Bamboo and Rattan
3 Center for Ecological Research, Northeast Forestry University
4 Key Laboratory of Dryland Agriculture, Ministry of Agriculture, Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences

An anomalous reduction in tree growth indices has been detected in tree-ring records from many circumpolar northern latitude sites in recent years, which was known as the divergence phenomenon. In order to understand whether the divergence phenomenon appeared at altitudinal treelines in east edge of Tibet Plateau, we analyzed the correlation coefficients between tree growth and climate variables before and after recent climate warming, respectively. The results showed that divergence phenomenon took place and varied with sites. Compared with that in 1955-1982, the temperature sensitivity in June declined, even disappeared during 1983-2012. In Songpan site, more than half of the sampled trees showed an increasing positive correlation with temperature from July to September, while others turned to be a negatively correlation. The temperature sensitivity in last November and December declined in Markang site. Only in Miyaluo site, the positive correlation between tree-ring index and temperature from July to September increased. Both the anomalous reduction or disappearance of temperature sensitivity and the divergent growth responses suggested that the divergence phenomenon was universal at altitudinal treelines in east edge of Tibet Plateau, which had potentially significant influences on the estimation of forest productivity and climatic reconstructions based on tree ring.

Email: liusr@caf.ac.cn

The Three-North Forestation Program of China: its status and ecological impact after 30 years

Zhu Jiaojun
Institute of Applied Ecology, Chinese Academy of Sciences

The Three-North Forestation Program (TNFP) of China is the world's largest forestation project, covering 42.4% of the Country. We systematically assessed its status and ecological impact 30 years after its initiation in 1978. Our results indicated that the forested area (defined as those with tree cover >30%, shrub cover ≥40%, or shelterbelt length >20 m) within the TNFP region increased by 1.204 × 107 ha during the 30 years between 1978 and 2008. The establishment of shelterbelts improved the corn yield by 9.49% in northeast China. The area subjected to soil erosion by water decreased by 36.40% from 6.716 × 107 ha in 1978 to 4.272 × 107 ha in 2008, with the most significant reduction occurred in areas with extreme and intensive soil erosion by water. Forests contributed 57.00% of the decrease based on path analysis. Within the TNFP region, the desertification area increased from 1978 to 2000 but decreased from 2000 to 2008, with a net reduction of 4.05×106 ha or 13.04% during the 30 years. However, forests only contributed 16.72% to the decrease of desertification area, mostly to area with slight desertification. Besides its direct impacts on the environments, the ongoing TNFP has greatly enhanced the people's awareness of environmental protection, and more importantly, attracted consistent attention and long-term commitment from Chinese government to the restoration and protection of the fragile ecosystems in the vast Three-North regions.

Email: jiaojunzhu@iae.ac.cn

Session D8-05 (56): Using tree rings to study events and morphological changes: relevance, methods and recent advances in dendrogeomorphic research

Review on the micro-sampling approach-based studies

Guo Xiali, Huang Jianguo
South China Botanical Garden of Chinese Academy of Science

Radial growth of trees is studied traditionally by monitoring the inter-annual growth pattern, namely exploring response of regular formed tree rings to the environmental signals and various natural issues. However, this method is limited in subtropical and tropical areas since the fuzzy tree rings boundaries. Micro-sampling approach can make up for that defect at a higher time resolution through monitoring cambium activity and xylem formation process of trees weekly at cellular level, and can also be used to reflect the tree growth process more accurately. This article will make a brief introduction to the development, implementation process and application prospect of micro-sampling approach combined with plenty researches on influence of internal factors (tree age, size, health condition, etc.), climatic factors (temperature, rainfall, photoperiod etc.), and non-climatic factors (competition, flood, fire, nitrogen deposition etc.) on tree growth. Besides the interlink between first growth (bud ,leaf growth)and secondary growth(stem growth) coupled with contents of non-structural-carbon is elucidated through micro-sampling approach, so as to better understanding physiological mechanism of trees adaption to the changing environment and providing practical reference for further forest management.

Email: guoxl@scbg.ac.cn

Projected changes of landslide activity in a warming climate

Jérôme Lopez-Saez[1], Christophe Corona[2], Nicolas Eckert[3], Markus Stoffel[4], Frédéric Berger[1]
1. Université Grenoble IRSTEA EMGR
2. CNRS GEOLAB
3. Université Grenoble Alpes IRSTEA ETNA
4. University of Geneva

Mountains are prone to geomorphological hazards including landslides, debris flows, mudflows and other expressions of slope instability that can lead to disasters and are particularly sensitive to climate change than other land surface at the same latitude. In the European Alps, the 20th century warming has been greater than the global and hemispheric (land and ocean combined) average resulting an increase in mean and maximum air temperatures, a shift in snow amount and sharply reduced snow cover duration mainly because of earlier spring snowmelt. The consequences of all these effects are likely to influence the temporal frequency and magnitude of mass wasting processes in mountain systems. As a result, the dynamics of, and controls on, geomorphological hazards under the effects of ongoing climate change are presently a major issue for landscape management and planning in the European Alps and similar mountain settings worldwide. Over recent years, scientists have attempted to attribute the severity or occurrence of geomorphological hazards to climate change in mountain systems. Nevertheless, research into the detection of changes in landslide activity over the past several decades of observed atmospheric warming as well as the identification of factors controlling climate-driven changes in landslide magnitude and frequency remain rather scarce and poorly understood due

to incomplete documentation of past events, especially those happened before satellite observations became available and observations are generally of short duration, difficult to scale up, temporally or spatially, and measured from specific field sites often using different methodologies and which in turn renders the understanding of process dynamics, triggers, and predictions of landslide activity difficult. In this study, we conducted the production of continuous multi-centennial (1860-2010), yearly-resolved landslide time series using tree-ring records coupled with the high spatial resolution reanalyzed SAFRAN meteorological data in order to identify their main climatic drivers over a 200-km^2 area comprising the geologic and geomorphic diversity found in the Barcelonnette basin located in the southern french Alps. The resulting model was further used to forecast landslide activity under a late-21st century moderate warming scenario. Based on a hierarchical bayesian framework and the model chain SCM, we determine that the combination of snow-rich winters and positive temperature anomalies in spring seems to have driven landslides reactivation in the past and in the future.

Email: jerome.lopez@irstea.fr

Session D8-05 (M1): Remote sensing & operational methods for monitoring forest landscapes and assessing risks

Spatio-temporal analyses and modelling of forest cover dynamics in Middle Povozhje

Eldar Kurbanov, Oleg Vorobev
Volga State University of Technology

Study of the causes and the scale of forest disturbances at regional and global levels is critical when developing solutions for effective forest management. This is especially true for forests of the Middle Volga region of the Russian Federation, which in recent decades have been subjected to severe fire, drought, led to their diebacks, windfalls and windbreaks. The purpose of the study is spatio-temporal analysis of forest cover dynamics in the Middle Volga region, based on retrospective assessment of satellite images of medium spatial resolution.

The research object is a large part of the Republic of Mari El and Chuvashia (Russia) territory with the area of over 3 million hectares. Age and spatial structure of forest stands within the evaluated area is represented by different types of vegetation, including boreal zone forest and zone of coniferous and small-leaved forests. The northern part of the research object is almost entirely represented by forested area, while almost half of the southern part area has a pronounced spatial patchiness of forest ecosystems.

Over the 30-year period the dynamics of vegetation changes (disturbance) is significantly influenced by both biotic and anthropogenic factors. Historically recurring in extremely dry seasons with an approximately equal time intervals wildfires especially stand out. Anthropogenic impact is represented by forestry activities in the form of clear cut areas, mainly in mature and over mature coniferous forest stands. Spatio-temporal dynamics were determined by analysis of a time series multi-temporal Landsat images of 30-year period. For a detailed assessment of spatial interactions multifactorial regression analysis was conducted using ArcGIS. The spatial structure of wildfires is represented by data of more than 80-years period.

Thematic maps of forest cover dynamics were developed using strata from satellite scenes of researched territory for 1985-2015 years. Thematic maps showing the disturbance of forest cover in 30 years was formed. Regularities of distribution of areas disturbed by clear cuts, forest fires of 2010 and other disturbances of the forest cover were investigated. Spatio-temporal analysis of forest cover was carried out, also taking into account the impact of its disturbance parameters (cuttings, fires).

Email: vorobievon@volgatech.net

From a 3D modeling tool to an operational approach for the assessment of the protective effect of mountain forests against rockfalls

Sylvain Dupire[1], Franck Bourrier[1], Jean-Matthieu Monnet[1], Frédéric Berger[1], Thomas Curt[2]
1. Université Grenoble Alpes - Irstea, UR EMGR, 2 rue de la Papeterie-BP76, F-38402 St-Marthin-dHères, France
2. Irstea, UR RECOVER, F-13185 Aix en Provence, France

Natural hazards are frequent in mountain areas where they regularly cause casualties and damages to human infrastructures. Mountain forests contribute in mitigating these hazards, in particular rockfalls. However, the evaluation of the hazard reduction can be difficult and operational approaches based on objective data are needed.

In this study, a 3D-rockfall model was adapted and used to simulate rockfalls propagation on 3886 different forest stands located in all the French Alps. The results of the simulations were used to calculate three quantitative indicators of the rockfall hazard reduction for each forest stand. Finally, the relation between forest characteristics and rockfall reduction was investigated.

Our results showed that the three indicators are strongly linked with three forest characteristics: the basal area, the mean diameter at breast height and the length of forest in the maximum slope direction. These three parameters were used to define six levels of protection only based on forest characteristics. Finally, the three forest parameters were calculated from Lidar data on a pilot area located in the French Alps to produce a map of the protective effect of the forests.

Email: sylvain.dupire@irstea.fr

Assessing land desertification area variability using a new spectral index MODIS-NDDI in Qinghai Province

Feng Lili, Jia Zhiqing
Institute of Desertification Studies, Qinghai Gonghe Desert Ecosystem Research Station, Chinese Academy of Forestry

Land desertification is one of the world’s most important global ecological environment problems and sensitive to global climate change. It is significant to propose a simple and effective method to acquire land desertification area on a large scale. In this study, band1 & band2 of Moderate Resolution Imaging Spectroradiometer (MODIS) reflectance data exhibited a large disparity in their spectral responses of different land covers. So these two bands were used to calculate a new spectral index called Normalized Difference Desertification Index (NDDI). Then, MODIS-NDDI and Gaofen-1(GF-1) data were used to obtain land desertification distribution of

Qinghai Province in 2001 and 2014. They were used to analyze land desertification area variability and relationships to meteorological factors. Results show that land desertification distribution has increasing trend towards the southern and western part of Qinghai Province. Along the longitude, high temperature, low precipitation and high wind speed contribute to advancing land desertification. Along the latitude, high wind speed contributes to advancing land desertification. Furthermore, land desertification becomes more serious in the region around East & West Taigener Salt Lake and North Huoluxun Lake. We must pay close attention to this situation in the future.

Email: fenglili_caf@163.com

Mapping rockfall release frequency from tree scars and simulated trajectories

Jean-Matthieu Monnet[1], Franck Bourrier[1], Céline Vargel[1], Jérôme Lopez-Saez[1], Christophe Corona[2], Frédéric Berger[1]
1. Université Grenoble Alpes, Irstea, UR EMGR
2. GEOLAB

Whereas numerous models now allow to simulate rockfall propagation in forest stands, the mapping of the release areas and associated frequency remains difficult, due to the very low number of observed events. Meanwhile, dendrochronological studies demonstrated that trees impacted by rockfall record information about the spatial distribution of rockfall trajectories. Here we tested, both with simulations and a real-case study, a framework for the mapping of release areas from observed tree impacts and simulated trajectories. The spatial distribution of impacts results from the propagation of rocks from several source cells with different release probabilities. Observations of impacts and simulation of trajectories make it possible to solve the system for the relative release frequencies. With simulated scenarios, we tested the capacity of this method to accurately map the release points depending on their number, distance and width, and on the tree density and diameters. Results show that individual release points can be accurately determined when a sufficient number of rockfall events have occurred. Forest characteristics have only a secondary influence. The method was successfully implemented in a real-case study were 1024 tree were inventoried for rock impacts.

Email: jean-matthieu.monnet@irstea.fr

Session D8-06 (33A), D8-07 (33B): Advancing on ecohydrological processes and watershed management

The climate-induced vegetation change and its associated hydrological response in a large forested watershed, Southeast Tibet, China

Zhang Mingfang[1,2], Ren Siyi[1], Ning Dingyuan[1]
1. School of Resources and Environment,
University of Electronic Science and Technology of China
2. Research Institute of Forest Ecology, Environment and Protection，
Chinese Academy of Forestry

The interactions between climate, vegetation, and water are key ecohydrological processes. Climate change can not only produce direct impact on hydrology, but indirect impact on it through vegetation. Although the impact of climate change or human-induced vegetation change on hydrology has often been examined in recent decades, the impact of climate-induced vegetation change on hydrology has been hardly studied. In this study, by use of modified double mass curves and ARIMA time series analysis, we investigated climate induced-vegetation change and its associated hydrological response in a large forested watershed (with limited anthropogenic disturbances) located in Southeast Tibet of China. We found that climate change and its induced vegetation change produced different effects on hydrology: climate change significantly increased both annual mean flow and dry season flow while its associated vegetation change decreased them in the last three decades. This could be explained by growing transpiration by forest or expanded subalpine meadows due to climate change. The result also showed that climate change and its associated vegetation change are two major drivers for streamflow variation especially in dry seasons. The relative contributions of climate change and its associated vegetation change on annual mean flow variation are 53% and 33%, respectively while the relative contribution of vegetation change due to climate change on dry season flow can be up to 46%. These findings are of great important for water resources management and ecosystem protection in the context of climate change.

Email: mingfangzhang@uestc.edu.cn

Forest landscape restoration contributes to climate change adaptation at the watershed scale

John Stanturf
US Forest Service

Forest Landscape Restoration (FLR) is a long-term process to regain ecological functionality and enhance human well-being. FLR broadens the scope to consider the entire landscape and incorporate human needs. Forest landscape restoration contributes to climate change adaptation by increasing productivity of landscapes, enhancing the resilience of forest ecosystems, and reducing the vulnerability of forest-dependent communities. Building adaptation actions into FLR projects enhances resilience, such as thinning stands to reduce transpiration loss as an adaptation to drought or introducing genetically diverse planting material with increased water use efficiency. Planning FLR to benefit hydrologic functioning begins at the upper reaches of a watershed where restoring forest cover protects soils from erosion or compaction. Maintaining or establishing ridge top forests to intercept mist and fog or restoring stream hydro period also restore functioning. Large-scale programs are underway to restore floodplain forests, which may be part of river restoration projects. Planting stream buffers in riparian zones increases shade and counteracts increased temperatures that risk aquatic species. Adaptation includes direct or indirect protection from climate hazards, for example restoring coastal mangroves to adapt to rising sea levels and protect from storm surges. Actions upstream to maintain salinity levels and sediment transfer increase resilience of coastal forests.

Email: jstanturf@fs.fed.us

Impacts of future climate change on carbon and water balances in U.S. national forests and grasslands

Ge Sun
Southern Research Station, USDA Forest Service

The 170 National Forests and Grasslands (NFs) with an area of 0.78 million Km2 in the conterminous United States are public lands that provide important ecosystem services such as clean water and timber supply to the American people. We have developed an monthly carbon and water accounting model (Water Supply Stress Index, WaSSI) to investigate the potential impacts of climate change on two key ecosystem functions (i.e., water yield and ecosystem productivity). The most recent climate projections derived from 20 Global Climate Models (GCMs) of the Coupled Model Intercomparison Project phase 5 (CMIP5) are used to generalize the future responses up to 2100. We find that future climate change may result in a significant reduction in water yield but an increase in forest productivity in NFs. On average, gross ecosystem productivity is projected to increase by 76 ~ 229 g C m^{-2} yr^{-1} (8% ~ 24%) while water yield is projected to decrease by 18 ~ 31 mm yr^{-1} (4% ~ 7%) by 2100 as a result of the combination of increased air temperature (+1.8 ~ +5.2 ℃) and precipitation (+17 ~ +51 mm yr^{-1}). The notable divergence in ecosystem services of water supply and carbon sequestration is expected to intensify under higher greenhouse gas emission and associated climate change in the future, posing greater challenges to managing NFs for both ecosystem services. This study also suggests that air temperature, rather than precipitation, dominates the hydrological changes in the U.S. as a whole by 2100.

Email: gesun@fs.fed.us

Linking landscape pattern and soil moisture dynamics in re-vegetation watersheds in Chinese Loess Plateau

Yang Lei, Chen Liding, Wei Wei
Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences

Soil moisture is important for plant growth in arid and semi-arid regions. For decreasing serious soil erosion, large-scale vegetation restoration was initiated in late 1990s in Chinese Loess Plateau. However, these activities may result in excessive water consumption without appropriate landscape management. In this study, 6 watersheds with different landscape structure and spatial pattern were selected. Spatial and temporal variation of soil moisture content in depth of 0-5 m were analyzed based on long-term field observation and spatial analysis method. The results showed that: (1) Introduced vegetation consumed excessive amount of water when compared with farmland and native grassland, and induced temporally stable soil desiccation. Landscape type and structure had significant influence on soil moisture. (2) The analysis of differences in soil moisture at hillslope and watershed scales indicated that landscape pattern determined the spatial and temporal variability of soil moisture. Soil moisture at watershed scale increased with the increasing area of farmland, and decreased with increasing percentage of introduced vegetation. (3) Large-scale vegetation restoration with introduced vegetation diminished the spatial heterogeneity of soil moisture at watershed scale. Landscape pattern adjustment could be used to improve the watershed management and maintain the sustainability of vegetation restoration.

Email: leiyang@rcees.ac.cn

Climate/land-use changes and ecohydrology in high-latitude Qinghai lake watershed on the Qinghai-Tibet Plateau

Li Xiaoyan
Beijing Normal University

Qinghai Lake watershed, located at the northeast of Qinghai-Tibet Plateau, is a sensitive and vulnerable region to global climate change. From 1961 and 2012, annual temperature showed an obvious increasing trend at a rate of 0.3℃/decade, but annual precipitation, runoff and evaporation had no overall upwards or downwards. Lake level decreased significantly during the period 1961-2004 at a rate of 7.6 cm/yr, while increasing significantly during the period 2004-2012 at a rate of 14 cm/yr. Lake level was most sensitive to climate and river run off.The magnitude of the land use/cover change was generally low, the percentage of the change of various land types relative to the total area was less than 1 per cent.SWAT simulation in the two sub-basins indicated the climate was dominant factor for variation of the stream flow, 83.4%- 89.9% of variation of the streamflow was attributed to climate change.

Energy partitioning and evaporation varied greatly in different ecosystems. Annual ET was 507.9 mm for *Potentilla fruticosa*, 493.2 mm for *Kobresia* meadow, 413.7mm for *Achnatherum Splendens* grassland and 436.1 mm for *Myricaria squamosa*.Fluctuations of ET at alpine ecosystems of Qinghai Lake watershed were primarily drove by net radiation, soil heat flux, temperature or soil water content. Freeze-thaw cycle had significant influence on surface energy flux and ET.

Email: 917512152@qq.com

The response of daily transpiration of larch plantation to varying weather and soil moisture in the dryland Northwestern China

Wang Yanhui
Chinese Academy of Forestry

Quantifying the forest transpiration response to varying environment is necessary for predicting forest water use and water yield. In this study, the daily transpiration (T) of Larix principis-rupprechtii plantation was measured at the semiarid Northwest China in the growing season of 2010, 2012 and 2014 with precipitation of 426, 519,592 mm. Using upper boundary line, the non-linear response of T to the relative extractable soil water (REW) of 0-60 cm, the daily potential evapotranspiration (PET) and the forest canopy leaf area index (LAI) was determined. The T increases following parabolic curve with rising PET, and exponential growth tending to a saturation limit with rising REW and LAI. Thereafter, an integrated model was set up by multiplying these tree relations, and its parameters were fitted using measured data in 2010 and 2012, while the data in 2014 were used to evaluate the model accuracy. It showed a high fitting degree (R^2 = 0.89; Nash coefficient = 0.79). Further analysis showed that the total T in growing season was limited firstly by PET (38.8-55.7%), followed by LAI (6.8-17.1%) and REW (0.4-6.5%), probably due to the relative high precipitation in study years and the stand position of slope foot which allows lateral flow can be used.

Email: wangyh@caf.ac.cn

Relative effects of wildfires, eucalypt forest logging, and drought on sediment yields in Southeastern New South Wales, Australia

Ashley Webb[1], Lisa Turner[2], Greg Hancock[3], Brad Jarrett[2]
1. NSW Department of Primary Industries, Tamworth Agricultural Institute, 4 Marsden Park Rd, Calala NSW 2340, Australia
2. Forestry Corporation of NSW
3. University of Newcastle

Long-term replicated catchment-scale erosion and sediment yield studies in the Eden region have revealed that current Best Management Practices (BMPs) are effective at reducing sediment loss during and following forestry operations. The Yambulla study is one of the longest-running continuous sediment yield research projects in Australia. It was established in 1977 within 6 small catchments that have experienced treatments including integrated logging, wildfires, salvage logging, alternate coupe harvesting and thinning, or remained undisturbed as controls. The long-term data set offers a unique opportunity to assess the relative effects of changing management practices and the type, intensity and distribution of disturbances, on soil erosion and sediment delivery to headwater streams. Following integrated logging in the 1970s sediment yields were increased by up to 300%. Similarly, following a high intensity wildfire in 1979, sediment yields were increased by up to 400%. The largest effects occurred, however, when salvage logging took place post-wildfire, with measured increases of up to 1000%. These effects took up to five years to fully return to pre-disturbance levels. By comparison, more recent harvesting operations (2007-2009), resulted in minor, short-lived and/or indetectable changes in sediment yields. This is attributed to a combination of the BMPs utilised during the harvesting operations, the ridgetop location of roads and log landings, the high degree of groundcover retained on skid trails and general harvest areas, coupled with the absence of high intensity storms in the immediate post-harvest period.

Email: ashley.webb@dpi.nsw.gov.au

Forest survival and hydrologic responses in a deep regolithic environment: options for management

Richard Harper[1,3], John Ruprecht[1], Keith Smettem[1,2], Ning Liu[1,3], Bernie Dell[1,3]
1. Murdoch University
2. University of Western Australia
3. Chinese Academy of Forestry

Jarrah (Eucalyptus marginata) forests cover 30,000 km^2 in south-western Australia, in deeply weathered landscapes formed from igneous rocks. Profiles are invariably infertile and 30-50 m deep. In the last 30-40 years there have been several profound changes in this forest including a major reduction in surface runoff, systematic decline in groundwater levels and consequent disconnection of groundwater from streams, and periodic periods of forest mortality. There has clearly been a change in the water balance of the forest and indications that the regolith is drying. This has been ascribed to a 15-20% reduction in mean annual rainfall over a 40 year period, specific years of well below average rainfall, and increased tree water use due to past forest disturbance such as timber harvesting. Deforestation, forest thinning and reforestation studies suggest decadal-scale responses in regolith hydrologic response. Questions arise about the implications of this regolith drying in an environment with future projections of reduced rainfall. For example, will this result in further tree mortality? Will the forest adjust to a new eco-hydrologic equilibrium? And what are the management options in a forest where the major economic drivers,

from timber and water production, have largely been removed? In this paper we describe the interactions between forest cover, forest ecology, hydrogeology, and water supply in this changing environment and draw conclusions applicable to other regions around the world that are experiencing rapid environmental change.

Email: r.harper@murdoch.edu.au

Responses of water and vegetation to climate changes in South-Western Australia

Ning Liu[1,2], Richard Harper[1,2], Keith Smettem[3], Pengsen Sun[4], Zhen Yu[5], Shirong Liu[2], Bernard Dell[1]

1. School of Veterinary and Life Sciences, Murdoch University, South Street, Murdoch, WA 6150 Australia

2. Chinese Academy of Forestry, Beijing 10091, China

3. School of Civil, Environmental and Mining Engineering, University of Western Australia, Nedlands, 6907, Australia

4. Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry, Beijing 10091, China

5. School of Natural Resources, West Virginia University, Morgantown, WV 26505, USA

South-western Australia has been subjected to recent climate change, with air temperature (T) increasing by 0.6°C and mean annual precipitation (P) reducing by 17% (up to 5 mm/year) since 1970. Along with these significant climate changes, dramatic declines of streamflow have occurred across the region. However, both forest dieback and an increasing trend of vegetation index have been observed, suggesting varied responses of vegetation to climate changes. In this study, around 150 catchments were analysed using the Mann-Kendall trend test and theoretical framework of the Budyko curve to study the rainfall-runoff relationship change, and deviation (d) and elasticity (e) of vegetation to climate change. A declining trend and relatively consistent change point (2000) of streamflow were found in most catchments, with about 50 of them showing significant declines (P elasticity (e) of different vegetation types followed the progression open shrubland > crop > forested catchments. Air temperature and soil moisture content were found as the two most important factors affecting vegetation's elasticity to climate change.

Email: ln1267@gmail.com

Quantifying bromeliads role in water and nutrients regulation in a cloud forest in Colombia: a preliminary approach

Raquel Romero, Juliana Higuera, Manuel Rodríguez

Los Andes University

Cloud forests (CF) are important mountain ecosystems that support high biodiversity. They are frequently covered by clouds, thus getting additional water input, known as horizontal precipitation (HP). CF in the humid tropics are characterized by their epiphytic vegetation abundance (mosses, bromeliads, orchids, ferns, etc.). Bromeliads are plants found only in tropical and subtropical America, mainly in Central and South America. In this study we did a preliminary research about the role of bromeliads capturing water from HP and also in nutrient regulation, in a CF in Eastern Cordillera (Colombia). In order to avoid entrance of direct precipitation, throughfall and stemflow and to allow only the entrance of HP, some bromeliads were roofed. Quantity of water captured

from HP was measured and physicochemical parameters monitored were: pH, dissolved oxygen, temperature, TOC, nutrients: total phosphorus and total nitrogen. Our results showed that bromeliads could capture relevant quantities of water from the HP in their phytotelmata. Quality measurements indicated that bromeliads' microenvironment in their phytotelmata is oxic. Bromeliads fertilized HP, increasing nutrients in the water and could buffer acid pH from direct precipitation. Preliminary we can conclude that bromeliads are important epiphytes in terms of water and nutrients regulation in CF.

Email: rb.romero34@uniandes.edu.co

Ecohydrological processes in the management of semiarid forests

Antonio D. del Campo del Campo, M. González-Sanchis, A. Lidón, A. García-Prats, C. Lull, I. Bautista
Research Institute of Water and Environmental Engineering, IIAMA. Universitat Politècnica de València

The complex relationships that exist between the forests and the hydrological cycle, coupled with the ongoing climatic changes and the diminishing trend on water resources, require the consideration of ecohydrological goals in forest planning and management. Here, we summarize and integrate previous results of ecohydrological-based forest management in eastern Spain in order to provide an overview on this topic. Control and thinning plots are compared in terms of hydrological performance, biological soil properties and nutrient cycles, tree growth climate sensitivity and improved resilience to wildfire.

In the water cycle, the results indicated a general enhancement of the hydrological cycle by favoring deep infiltration after the thinning treatments. At the same time, there was a general dismissing of stand transpiration despite the fact that tree water use increased after thinning. Soil evaporation was only slightly increased with thinning. Regarding soil and biogeochemical cycles, thinning increased soil organic C and nitrification processes, but no significant effects in soil CO_2 emission and microbial activity (phosphatase and urease) were detected. Forest management appeared to increase the potassium out coming via runoff, while the fluxes of C, N, and P were not significantly affected. Regarding tree growth and vigor, increased resources' availability with thinning had effects in primary and secondary growth and total biomass. For instance, basal area was 4.1 and 17.3 cm^2 $year^{-1}$ for the control and the thinned trees respectively. Improved forest resilience had two dimensions: tree-climate sensitivity and wildfire susceptibility. Thinning made the trees less sensitive to water shortages, with trees in the non-thinned plot relying more heavily on current year precipitation than those thinned. By the same, Water Use Efficiency (WUE) grew proportionally with decreasing forest cover. Regarding wildfire risk, thinning had a structural effect by breaking fuel continuity but also a short-term dynamic effect by modifying the microclimate and the vegetation status. A modified Keetch–Byram's drought index proved to be sensitive to our silvicultural operations in terms of a decreased forest fire risk.

Although it is widely recognized the need of a proactive-adaptive silviculture, it'll be only operationally possible if non-marketed ecosystem services are explicitly incorporated and quantified into forest management. Hydrology-oriented or ecohydrology-based silviculture is just an example that poses many opportunities to make silviculture more effective under water scarcity scenarios.

Email: ancamga@upv.es

Session D8-06 (90): Nutrient dynamics in forest soils: the foundation of sustainable forest environments

Improving soil fertility and pine productivity through beneficial use of biosolids

Xue Jianming[1], Mark Kimberley[1], Gerty Gielen[1], Louis Tremblay[2], Olivier Champeau[2], Craig Ross[3], Jacqui Horswell[4]
1. Scion
2. Cawthron Institute
3. Landcare
4. ESR

This study investigated the impacts on soil properties, tree nutrition and growth of long-term biosolids application to a radiata pine plantation forest growing on a Sandy Raw Soil. Biosolids were applied to the trial site every three years from tree age 6 to 22 years at three application rates: 0 (Control), 300 (Standard) and 600 (High) kg N ha^{-1}. Tree nutrition status and growth were monitored annually, soil properties every three years, and groundwater quality quarterly. Both the Standard and High biosolids treatments significantly increased soil total C, N and P, Olsen P, and reduced soil pH at 0-50 cm, and increased soil total N at 50-75 cm. The High biosolids treatment also increased concentrations of soil total Cr at 0-25 cm, and Zn at 25-50 cm, but they were considered very low for a soil. Ecotoxicological assessment showed no significant adverse effects of biosolids application on springtails reproduction and soil microbial biomass. Biosolids application significantly increased foliar N concentration and tree stem volume growth. We concluded that repeated application of biosolids to a plantation forest on a poor site could significantly improve soil fertility, tree nutrition and site productivity without causing significant adverse impact on the environment.

Email: jianming.xue@scionresearch.com

How do forests cope with ancient soils?

Dan Binkley[1], Mark Adams[2]
1. Northern Arizona University
2. University of Sydney

Time is a core topic for many studies in ecology, forestry, and soils.Ecological dynamics occur across timescales of seconds to centuries (or more), with major changes in forest composition, structure, and processes. Intricate cycles of nutrients sustain forest growth as soils develop over decades, centuries, and millennia. After hundreds of thousands of years, soil fertility is thought to decline as cumulative losses of nutrients leave very little behind for trees to use. Ancient soils (> 1 million years) might be so low in nutrient capital that tree growth should be poor. Such ancient soils occupy vast areas, and they typically support vigorously growing forests. We explore the factors that support the growth of forests on ancient soils. Humid conditions that lead to intense soil weathering also develop deep soil; deep rooting zones (>10 m) are characteristic of ancient-soil forests. These forests may show great ability to access “unavailable” nutrients, as

well as higher efficiency of using and recycling nutrients, but these factors do not appear important in all cases. Low annual fluxes airborne inputs (rain and dust) help sustain nutrient pools indefinitely. These "background" features of ancient soils form the foundation for management regimes that will sustain vigorous forests.

Email: dan.binkley@alumni.ubc.ca

Intensification of planted forest management and biomass harvests: consequences for soils sustainability

Laurent Augusto[1], Mark Bakker[2], Jean-Michel Carnus[1], Ander Arias Gonzales[3], Nahia Gartzia Bengoetxea[3], Pierre Trichet[1]
1. INRA
2. Bordeaux Science Agro
3. Neiker-Tecnalia

With limited land availability globally, sustainable intensification in planted forests management will be required to meet future wood demand, thus potentially reducing pressure on natural forests, and on agricultural lands for food production. In parallel, climatic conditions will change dramatically in many parts of the world and adaptation strategies need to be implemented and deployed rapidly for planted forests. Responses to rapid climate changes and increasing wood and biomass market demands include a range of planted forest management options and intensification strategies with various impacts on soil fertility, site productivity and the wider environment. Some of them could be deleterious to the long-term capability of ecosystems to sustain production of biomass. Examples of current management options to improve production including increased harvest of residues (canopies, stumps, roots), shorter rotations, and land application of waste products (wood ashes, biosolids) will be presented in the context of pine plantations in South West Europe. Assessment of impacts of those intensification options on soil sustainability will be discussed on the basis of results from impact studies on a range of planted forest sites and from initial experimental results of a large-scale forest research infrastructure where several silvicultural regimes are tested. Results show that some intensification options will have limited effects on biogeochemical cycles and can be considered in regional adaptation strategies of planted forests.

Email: laugusto@bordeaux.inra.fr

Impact of fertilization on nitrogen dynamics in the forest floor of pine plantaitons in the Southern United States

Thomas Fox[1], Jay Raymond[1], Chris Kiser[2]
1. Virginia Tech University
2. Abraham Baldwin Agricultural College

Traditional models of nutrient dynamics in O horizons suggest that decomposition and subsequent mineralization of N from these horizons is a significant sources of N in forest ecosystems. However, in many pine systems, decomposition of the O horizon is slow which in turn leads to a build up of the forest floor through time that is accompanied by immobilization of N. Thus the O horizon is actually a sink for N in conifer ecosystems, such as *Pinus taeda* stands in the southern United States. This sequestration and immobilization of N in the O horizon seems to

decrease N availability through time in undisturbed stands that leads to increased N limitations as the stands age. This occurs even in locations where temperature and moisture are high, such as subtropical regions. Following disturbances, such as thinning or clear felling, these O horizons decompose rapidly and large amounts of N are mineralized in the well-known Assart Effect. This paper will present data on organic matter and N accumulation in the forest floor of loblolly pine stands and its impact on N availability. It will also discuss potential mechanisms that lead to the build up of the forest floor in these conifer systems.

Email: trfox@vt.edu

Does increased trend in soil water inorganic nitrogen concentration predict incidence of tree vitality?

Liisa Ukonmaanaho, Tiina M. Nieminen, Antti-Jussi Lindroos, Seppo Nevalainen, Martti Lindgren, Kirsti Derome, Pasi Rautio, Maija Salemaa, Pekka Nöjd, Heikki Nuorteva, Paivi Merila
Natural Resources Institute Finland

Studies on ecosystem changes associated with forest dieback caused by insect attacks or decay fungi usually begin after an outbreak, and data on the dynamics of forest decay prior to and during infestations are lacking. Such dynamics may represent an important ecosystem factor, controlling nutrient inputs to forest floor and consequently the rate and duration of biochemical changes in soils. We will report trends in defoliation, litterfall flux and inorganic nitrogen (N) concentration in deposition and soil water before and after a bark beetle outbreak (Ips typographus) in a boreal spruce forest in Finland. In addition we report results from the healthy site. The collection and analysis of deposition, soil water, soil, litterfall and the assessment of tree defoliation were conducted according to the ICP Forests manual (1996-2015). Results showed that although N deposition was at the same level at both sites, especially the soil water NO^{3-}N concentration started to increase already before the bark beetle outbreak at the infected site, but not at the healthy site. In addition litterfall flux and defoliation increased at the attacked site. The results indicate that changes in soil water inorganic N concentrations may predict incidence of tree vitality loss symptoms, such as insect infection, under low N deposition areas.

Email: liisa.ukonmaanaho@luke.fi

The logging impacts on the Hg and MeHg load from drained peatland forests in Finland

Liisa Ukonmaanaho, Juha Heikkinen, Juha Piispanen, Ari Laurén, Tiina M. Nieminen
Natural Resources Institute Finland

According to current Finnish energy policy, logging residues will have to be used in addition to stemwood in order to meet targets for bioenergy production. In Finland. 4.9 million ha of peatlands have been drained for forestry purposes, and much of it will be harvested within 10 to 30 years. This biomass would provide a major source of bioenergy. However, forest harvesting, especially when intensified harvesting method as whole-tree harvesting with stump lifting (WTHs) is used, may increase mercury (Hg) and methylmercury (MeHg) leaching to recipient water courses. The effect can be enhanced if the underlying bedrock and overburden soil contain Hg. The impact of stem-only harvesting (SOH) and WTHs on the concentrations of Hg and MeHg as well as several other variables in the ditch water was studied using a paired catchment approach in eight drained peatland dominated catchments in Finland (2008-2014). Four of the catchments were on felsic

bedrock, four on black schist bedrock containing heavy metals. Results indicate that there are differences in drainage water quality and quantity before and after harvesting (both SOH and WTHs) as well as between the two bedrock types. The change was strongest first two years after harvesting.

Email: liisa.ukonmaanaho@luke.fi

Differences in the partitioning of applied fertilizer nitrogen after a spring and summer fertilization in mid-rotation loblolly pine plantations (*Pinus taeda L*) in the southern United States

Jay Raymond, Thomas Fox, Brian Strahm, Jose Zerpa
Virginia Tech

The ecosystem recovery of four N containing fertilizers (urea, three enhanced efficiency fertilizers (EEFs)) enriched with 15N were compared after two application seasons in mid-rotation loblolly pine stands (*Pinus taeda L.*) across the southern United States. Total ecosystem fertilizer N recovery was greater for all EEFs (78% to 84%) compared to urea (52%) with no differences among individual EEFs or between seasons. Fertilizer N recovery in the soil (forest floor + 0-30cm) was greater for EEFs (36% to 43%) compared to urea (21%), with no treatment differences in fertilizer N recovery in the canopy (13.6% to 21.6%), stem (5.5% to 7.7%), or roots (10% to 13%). One primary difference in fertilizer N recovery between application seasons occurred in the soil (0-15cm) where more fertilizer N was recovered for EEFs (27% to 36%) in the summer compared to spring (22% to 29%). Numerous treatment differences occurred in individual ecosystem components for 15N values and N content in the same season, with minor differences between seasons. This research highlights increased fertilizer N recovery and ecosystem partitioning of fertilizer N using EEFs compared to urea in southern loblolly pine plantations, potentially increasing the fertilizer N use efficiency of these pine plantations.

Email: jayer11@vt.edu

The effects of understory vegetation and organic horizon removal on some ecological properties in the *Pinus rigida* plantation

Si Ho Han[1], Loth Meng[1], Min Seok Cho[2], Byung Bae Park[1]
1. Chungnam national university
2. Forest Practice Center

Competition between crop trees and other vegetation for water and nutrient resources is one of concerns for forest managers. We investigated the effects of the removal of understory vegetation and organic layer of the forest floor on crop tree growth, understory regeneration, litterfall and fine root production. We removed 21.5 t/ha for understory vegetation and 38.6 t/ha for organic amount on the forest floor at 4 plots among 8 on June 2015. Before and after treatments, litterfall was collected from 1m height litter trap and then was separated into leaves, twig, bark, seed, etc. Eighteen soil cores were taken to estimate fine root biomass by soil depth. Roots were divided into living and dead roots (three diameter classes: 0-1, 1-2, 2-5mm). Fine root biomass < 2 mm in diameter was composed of about 50% of total fine root mass, 310 g/m^2. Total litterfall amount was 530 g/m^2, which was divided into needle, 296 g/m^2, and other leaves, 78 g/m^2, which is 20% of leaf litterfall in this plantation. We are still measuring crop tree growth, understory regeneration,

litterfall and fine root production after the treatment. We don't know yet if the removal of understory vegetation influences on crop tree productivity positively or negatively. However, our findings will improve our understanding the role of understory vegetation in nutrient cycling in planted forests.

Email: bupleurumhan@gmail.com

Nitrogen uptake and allocation in *Populus simonii* in different seasons supplied with isotopically-labeled ammonium or nitrate

Zhang Chunxia
Northwest A&F University

Appropriate fertilization is crucial to maximum plant growth and improving nitrogen use efficiency. The main objective of this study was to examine nitrogen uptake and allocation of *Populus simonii* supplied with different forms of nitrogen in different seasons. We determined nitrogen uptake and allocation of *Populus simonii* potted seedlings after a 4 d supply of $^{15}NH^{4-}N$ and $^{15}NO^{3-}N$ in May, July and September. The total uptake of $^{15}NO^{3-}N$ was two-fold higher than that of $^{15}NH^{4-}N$ in all the investigated timings. Nitrogen uptake efficiency was highest in September and lowest in May. ^{15}N was present mainly in leaves in May and July, and was mainly stored in roots and stems in autumn. The seedlings fertilized with $NO^{3-}N$ in July had good growth with high photosynthetic rate and total biomass. This data contribute to understanding nitrogen uptake in different seasons supplied with different forms of nitrogen. This provides important theoretical bases for fertilizer management of poplar plantations.

Email: czhang@nwsuaf.edu.cn

Session D8-06 (81): Old-growth forests in a changing world: relict of the past or ecosystem service generator for the future

Venerable old-growth and the wet sclerophyll forests of Australia: heritage, perpetuation and inspiration

Grant Wardell-Johnson
Curtin University

Wet sclerophyll forests (WSF) occupy a small fraction of Australia (0.75% or 4.83 m ha) but are disproportionately important; economically, ecologically and culturally. The dominant eucalypts of old-growth WSF are shade intolerant, fire regenerators, capable of giant stature, with rapid growth in the first 100 years of life and senescing after c. 500 years. As a result, these forests store immense volumes of carbon within complex structures of tall trees, fallen logs and organic rich soils. Carbon content varies spatio-temporally within forest type, linked to fire frequency and management history. Anthropogenic climate change interacting with other processes poses great threat to the ecological integrity of remaining old-growth because WSF has a suite of traits making it particularly vulnerable to warming and drying. Rising temperatures disadvantage large trees, and rapid (< 150 years) return-times of high intensity fire events reduces capacity of WSF species to recover, leading to replacement with shorter-lived tree communities able to persist following more frequent fires. In this paper, we provide an overview of old-growth in Australia's WSFs, assess the aesthetic, scientific and cultural significance of these forests, and outline approaches to enable continued inspiration through perpetuation of these extraordinary environments.

Email: g.wardell-johnson@curtin.edu.au

Spatial analysis of remnant tree effects in a secondary abies-betula forest on the eastern edge of the Qinghai–Tibetan Plateau, China

Miao Ning
Sichuan University

Remnant trees, remaining after large-scale disturbance of forests, have been shown to exhibit noticeable ecological effects on the recovery of ecosystem functions. Although it is well known that remnant trees may serve as dispersal foci, their effects on the spatial pattern of later stages of dominant tree species in natural secondary forest have not been fully appreciated. To explore the spatial influences of remnant trees on later stages of dominant tree species of a secondary Abies-Betula forest on the eastern edge of the Qinghai–Tibetan Plateau, we mapped all the trees in a 200m×200m plot. We used spatial point pattern analysis including O-ring statistics to analyze the spatial associations between old-growth remnant trees and two dominant tree species of later stages. Abies faxoniana and Betula albo-sinensis, comparing different size-classes at different spatial scales. Our results showed that saplings, small trees, and medium trees of the shade-tolerant species, A. faxoniana, showed significantly positive associations to the old-growth remnant trees of both dominant species, suggesting that remnant trees provided favourable sites for the regeneration of shade-tolerant species. In contrast, small, and medium trees of the shade-intolerant species, B. albo-sinensis, showed significantly negative associations to old-growth remnant trees of both dominant species, suggesting that the remnant trees hinder their regeneration. For old-growth remnant trees, the $O_{12}(r)$ function value (density) of their seedlings, saplings, small trees, and medium trees was calculated at increasingly greater concentric scales (with radius from 0 to 100m from the remnant trees). Tree density first increased rapidly from 0 to 10m or 20m radius (distance from remnant tree) and then decreased continually away from remnant trees, consistent in part with the population recruitment curve proposed by the Janzen–Connell model. We found that saplings, small trees, and medium trees of A. faxoniana tended to distribute within a particular range of annuli around the remnant trees of A. faxoniana, with the densities of the three largest size-classes reaching a maximum within 3–6m of the remnant tree. The densities beyond the parent remnant trees continued to show an increasingly expanding zone of attraction around the remnant tree. In effect, the small and medium A. faxoniana trees coalesced around remnant trees to create increasingly enlarged canopy cover areas, which served simultaneously as protected zones for A. faxoniana regeneration and extended exclusion zones for B. albo-sinensis and similar shade intolerant species.

Email: miaoning@scu.edu.cn

Climatic sensitivity of trees in the most biodiverse forest in Mongolia

Oyunsanaa Byambasuren[1], Johann G. Goldammer[1], Baatarbileg Nachin[1], Neil Pederso[1]
1. National University of Mongolia, University Str. 3, 14201 Ulaanbaatar, Mongolia
2. The Global Fire Monitoring Center, Georges-Koehler-Allee 75 79110 Freiburg, Germany
3. National University of Mongolia, University Str. 3, 14201 Ulaanbaatar, Mongolia

4. Harvard Forest, Harvard University, Petersham, Massachusetts, USA

Many climatic factors strongly play a role in the growth of trees and dynamics of forested ecosystems. Among these, temperature, precipitation, and snowpack may be among the most important in mountains environments. To understand past and future effects of these individual factors on forest growth and its dynamics is always challenging. In this study we aim to understand the climatic sensitivity of the most diverse forests in Mongolia, the Khentii Mountains of northcentral Mongolia. Mongolia has experienced significant changes in climate over the last few decades, including rapid warming over the last 30 years and a strong pluvial and two droughts during that same time period. Notably, the most recent drought, from the late-1990s to early 2000s, might have been exacerbated by significant warming over Asia. By examining tree ring records of all dominant tree species from a wide range of sizes and ages over 1000m of elevation in two forest types, we will have significant insight into the sensitivity of this diverse region to climatic change. Using tree-ring chronologies of five main tree species, we found that trees display distinct correlation features with climatic variables, although the growth of all species are generally correlated with one another. Among the tree species examined here, *Pinus sylvestris* was strongly associated with annual streamflow variability, which is a large-scale indicator of moisture availability. Information obtained from this study can expand knowledge about forests growing in such extreme conditions. Our findings will also help guide forest management decisions under a changing climate.

Email: oyunsanaa@seas.num.edu.mn

Session D8-07 (M3): Co-existence of human and wildlife in changing forest landscapes, societies and climates

Modeling the risk of bark stripping by chacma baboons (*Papio ursinus*) in the pine plantations of the Mpumalanga province, South Africa

Ilaria Germishuizen[1], Kabir Peerbhay[1], Riyad Ismail[2]
1. ICFR
2. SAPPI Forests

Conflict between humans and primates is globally on the increase due to the ability of certain primate species to adapt to transformed environments, often resulting in damage to agricultural crops and planted forests. Bark stripping of pine trees by baboons (Papio ursinus) in commercial plantations is challenging the sustainability of the forestry industry in the Mpumalanga Province of South Africa. Several studies have investigated the drivers of this behavior, however, a variety of factors appears to be linked to this activity. This study applies a machine learning technique, random forests (RF), to develop a baboon damage risk model by relating environmental predictors to the presence and absence of baboon damage caused by bark stripping. The random forests classifier was successful in predicting damage occurrence (F1 score = 0.801; AUC=0.945). Baboons seem to generally cause more damage in pine stands located on high productivity sites, where food resources are more abundant and less time is spent foraging. The model was applied to the pine plantation landscape of the Mpumalanga province for risk evaluation in support of management decisions and long term strategy development for the sustainability of the forestry industry in the future.

Email: ilaria.germishuizen@icfr.ukzn.ac.za

Human activity mediates reciprocal distribution and niche separation of two sympatric mongoose species in Pothwar Plateau, Pakistan

Tariq Mahmood, Riaz Hussain, faraz Akrim, Hira Fatima, Maqsood Anwar, Muhammad sajid Nadeem

PMAS-Arid Agriculture University Rawalpindi 46300 pakistan

Ecologically and morphologically similar species living in sympatry are predicted to partition their resources, though resources themselves may vary in time and space and in relation to extrinsic factors. Here we show that two sympatric species of carnivores vary in their distribution along a gradient of human activity and one species exploits a wider range of food sources. We recorded distribution of two sympatric small carnivores; small Indian mongoose (*Herpestes javanicus*) and the grey mongoose (*Herpestes edwardsii*) through reconnaissance surveys within high, medium and low human-activity areas of the Pothwar Plateau. Population density of each mongoose species was calculated by Active Burrows counts at 12 selected sampling sites located within three different human activity areas of the Plateau from November 2011 to June 2013. Diet composition of both species was investigated through faecal samples analysis. We found that distribution of the two mongoose species. Interacted significantly with human activity levels; small Indian mongoose was found highly distributed where human activity level was high and vice versa for the grey mongoose species. The grey mongoose showed a wider food niche breadth as compared to the small Indian mongoose, while the food niche overlapped between the two species measured by Pianka's Index was 0.95.

Email: tariqjanjua75@uaar.edu.pk

Wildlife in local livelihood development: collision between regulations in forest laws and hunting legislation in the Republic of Moldova

Vitalie Gulca

1. Forest Research and Management Institute, Chisinau, Republic of Moldova

2. Forestry and Public Gardens Department, State Agrarian University of Moldova

According to the Wildlife Law and the Forest Code there are three principal authorities responsible for management and control of the hunting fund: first, the forest authority which wants to improve the hunting economy but does not have sufficient money to do this work; second, the environment authority which wants to protect wildlife without exploitation; and third, the local authorities having even nowadays game problems wishing to participate in privileged hunting as long ago. In consequence, agricultural lands as part of wildlife habitats are administered by local authorities and managed by the Society of Hunters and Fishermen while the central forest authority manages about 800 forest units from 0.5 ha to 1,500 ha spreading on the whole agricultural territory. But wildlife does not ask who the manager is and during the winter many species prefer forest habitats while during summer they prefer corn or other fields. The problem is much more complicated since agricultural lands are divided among a multitude of private owners not accepting wildlife damage to agricultural crops. The wildlife crisis can be attributed to a range of factors: poaching, out-of-date legislation, and lack of educated staff and capacity building. Investigations point out that wildlife management is in conflict with sustainable forest management, agriculture and livestock farming which constitute together the livelihood for most part of local population. This

study highlights the fact that existing legislation presents an obstacle for communities to understand and realize the utility of wildlife as an ecosystem service.

Email: vitalie.gulca@gmail.com

Session D8-07 (M2): Managing ecosystem services in forests around the world

An ecologically-based practical model for assessing Gingko agro-forestry management

Sun Yuan[1], Cao Fuliang[1], Wei Xiaohua[2], Yang Qing[1]
1. Nanjing Forestry University
2. University of British Columbia

The tropic and sub-tropic forests play a crucial role in forest carbon budget and mitigation of climate change impacts. However, current world tropic forests continue to decline in an alarming rate both in quantity and quality. The tropic and sub-tropic countries particularly in developing countries face severe pressures on both relieve of poverty and environment degradation. To protect tropic and sub-tropic forests, any effective measures must consider both economic and ecological dimensions synergistically. The purpose of this paper was to synthesize our long-term studies on the Gingko agro-forestry ecological models to demonstrate possibility of achieving relieve of poverty while protecting environment; and to discuss their wide applications in China and other developing countries. In these research we combine our 20 years experiments, from Cheng (2010) Tian (2012), Chen (2013), Dong (2013), Di (2014) and Zhang (2015). The assessment method conducted in the paper were synthetic degree with Harmony Degree and Development Degree from Gu (2010) and Sun (2011). Through our 20-year experiments and in-depth analysis, we have found that Ginkgo-Wheat-Peanut (G+W+P), Ginkgo-Rapeseed-Peanut (G+R+P) is the best model when compared with pure Gingko plantation and pure agriculture crops in terms of integrated performance of ecological, economic and social indicators. The HD and DD for the mix systems were highest and most stable.

We further estimate that if this successful model is applied in all Gingko plantation forests and all applicable agriculture lands in Jiangsu province, China, the revenue per hectare per year will be increased of 38%, it would allow 18.9 millions of people be out of poverty while sustaining environment, with its total economic contribution in 2012. We conclude that any successful and practical model must incorporate both economic and ecological design into consideration.

Email: sunyhot23@hotmail.com

Analysis of institutional-economic factors explaining the country-specific success of payments for ecosystem services

Matthias Bösch
Thünen Institute of International Forestry and Forest Economics

Intact ecosystems are essential for human well-being. However, the depletion of natural resources and the resulting global degradation of ecosystems are becoming more and more apparent. When ecosystem services and the benefits they provide are lost, it is challenging and often extremely costly to offset this loss. Most recently, striking evidence for this problem has been shown by the international TEEB initiative ("The Economics of Ecosystems and Biodiversity").

Payments for Ecosystem Services (PES) are a relatively new economic policy instrument that aims at valuating ecosystem services and, at the same time, providing land users with income opportunities. However, the many case studies of PES programs from all over the world do not provide a clear picture of the institutional-economic factors that are crucial for the success in a specific country. The purpose of this study is to identify those factors that are decisive for the supply of PES schemes in a specific country using binary logistic regression. In particular, we test the influence of institutional conditions like security of property rights, legal certainty, and corruption. This crossnational study could contribute to identify countries where future PES schemes can be successfully established.

Email: matthias.boesch@thuenen.de

Local people′s demand for forest ecosystem services: a case study in northern Vietnam

Thi Phuong Mai Nguyen[1,2], Renate Bürger-Arndt[1]

1. Faculty of Forest sciences and Forest Ecology, Goerg-August G?ttingen University, Germany

2. Faculty of Environment and Earth Sciences, Thai Nguyen University of Sciences, Vietnam

The ecosystem services (ES) concept was considered to be a mainstream in natural management at all levels of decision-making (Groot et al 2010) and it was applied in forest management in some countries. To communicate this concepts at the local scale, the demand side needs to be sufficiently investigated (Burkhard et al. 2014) to support and optimize forest management and policy decision-making to respond to local beneficiaries (Casado-Arzuaga et al. 2013). This research focuses on identifying people′s demand for forest ecosystem services (FES) and their assessment within the ES framework in two mountainous communes in northern Vietnam. Their demand for FES refers to what they want and need (could be accessible or not due to some reasons) from local forests to serve their life. Both qualitative and quantitative data was collected by group interviews, household survey, individual expert interviews and observation. The research illustrated that local people have high demands concerning forests for their domestic use purposes, especially, demand for water supply, construction wood and firewood. Although local demands have changed over time, these services are still major concerns while the supply, following their assessment, has been reduced although supply of some non-timber forest products still meet local demand.

Email: tnguyen1@gwdg.de

Tradeoffs between efficiency of the protection against rockfalls and vulnerability to fires in mountain forests

Sylvain Dupire[1], Thomas Curt[2]

1. Université Grenoble Alpes - Irstea, UR EMGR, 2 rue de la Papeterie-BP76, F-38402 St-Marthin-dHères, France

2. Irstea, UR RECOVER, F-13185 Aix en Provence, France

A significant part of Alpine forests are located between starting areas of rocks and zones of human activities. These forests are natural barriers against rockfalls and contribute in reducing the risk of human casualties and damages to infrastructures. This particular ecosystem service can unfortunately be disrupted by events such as fires, likely to be more frequent in future years due to climate changes and socio-economic trends.

The aims of this study are 1) to evaluate which protection forests against rockfall are subjected to fires, 2) to analyze the consequences of different fire scenarios on their capacity to reduce natural hazards and 3) to identify forest management practices that could optimize the tradeoffs between rockfall protection and fire vulnerability.

First, a functional analysis for each natural hazard was carried out on 3886 different stands located in all the French Alps. Quantitative indicators were defined to evaluate the protective effect of a forest against rockfall and the tree mortality after different fire scenarios. Second, a multi-risk analysis was performed in order to compare the indicator of rockfall protection before and after a fire event. Finally, the influence of forest structure and composition on the optimal trade-off was investigated.

Email: sylvain.dupire@irstea.fr France

Comparing and contrasting the role of ecosystem services in forests of developing, emerging and developed countries

Vitalie Gulca[1,2], Robert Deal[3]
1. Forest Research and Management Institute
2. Forestry and Public Gardens Department, State Agrarian University of Moldova
3. USDA Forest Service, PNW Research Station, OR, USA

This study assessed the flow of ecosystem services and the role these services provide in both poor and rich countries. This research consisted of two primary objectives. First, we assessed losses of ecosystem function from disturbances including flooding and droughts, wildfire, ice-storms, insects and invasive species. Then we assessed the effect of forest restoration and the positive role that the creation of new forests could provide for a broad suite of forest ecosystem services. To attain these objectives we first describe some of the emerging international issues relating to ecosystem services. Then we assess the role of forest ecosystem services in different regions of the world looking broadly at developing, emerging and fully developed countries. Also, we analyze the differences and similarities in utilization of forest services between poor and rich countries. While most developing countries' economies depend largely on natural resources, the new opportunities with ecosystem services for landowners in the region are not well understood. Finally we propose recommendations to conserve ecosystem services and help rural people in poor countries and suggest proposals to maintain ecosystem services in emerging and developed counties.

Email: vitalie.gulca@gmail.com

Oral Presentations of the 4th Forest Science Forum

The 4th Forest Science Forum

Session CSF-01: Tackling climate change adaptation in tropical and subtropical forests

Close-to-nature uneven-aged and mixed forest is the future

Hou Yuanzhao
Chinese Academy of Forestry

Forests are the significant player of green economy, the foundation of national wealth, the guarantee of the basic people well-being and the provider of the fundamental security for people. Multi-functional forest puts the equal attention to both ecological and on economic functions, and thus acts as the main part of forest resources.

In China, multi-functional forest resources mainly refer to secondary nature forest and common planted forest. These forest resources needed to be conversed to close-to-nature mixed and uneven-aged forest.

The concept and advantage of close-to-nature uneven-aged and mixed forest is illustrated in this presentation. It found that close-to-nature conversion is the approach to form uneven-aged and mixed forest. What should be studied for cultivating close-to-nature uneven-aged and mixed forest is also expounded in the presentation.

Innovations for the fourth-cycle breeding program for loblolly pine in the southern United States

Steve McKeand (presenting author), Austin Heine, Trevor Walker, Daniel Genung, Ross Whetten, Tori Brooks, April Meeks, J.B. Jett, and Fikret Isik
Cooperative Tree Improvement Program, Department of Forestry and Environmental Resources, NC State University, Raleigh, NC 27695-8002, USA

Tree breeding programs throughout the world have resulted in enormous productivity, quality, and financial benefits to landowners. In the southern United States, the economic impact from 60 years of tree improvement has been enormous. Over 300,000 hectares are planted each year with seedlings from the breeding efforts of members and staff of the NC State University Cooperative Tree Improvement Program. The present value of continued genetic gains from tree improvement is estimated to be $1.9 billion USD to landowners and citizens in the southern US. A significant challenge for tree breeding programs is the dwindling capacity to conduct breeding, testing, and selection, so all tree improvement activities must be as efficient as possible in future breeding cycles. For the Cooperative's fourth breeding cycle, we implemented the Differential Evolution (Kinghorn 2011. GSE 43:4) algorithm developed for animal breeding programs to develop a mating design for the fourth cycle. The objective was to increase genetic gain in the short term while maintaining long-term genetic diversity so gain can continue for multiple generations. Our research seeks to strengthen the efficiency of traditional breeding while enhancing resources for its members. We will discuss genomic selection and climate change research projects.

Multipurpose forestry - an option for future

Heinrich Spiecker
Albert-Ludwigs-University Freiburg

The demand of society for ecosystem services is continuously increasing. This trend will continue; even so, the future values for the services may change. How can forest management best deliver the ecosystem services demanded by society? The answer to this challenging question varies depending on the specific local conditions such as the state of the forest, the specific ecological and economic situation, and the values and perception of society. In addition, enhanced scientific knowledge, practical experience and mentality of people may alter these values. Ecological and economic conditions change over time as well. Therefore, the adaptive capacity of the ecosystem providing varying services in a satisfactory way has to be high. Some of these services may be conflicting, others neutral or even synergistic. Finding the appropriate mix of ecosystem services for achieving the highest benefit for the society is an everlasting challenge. We observe world wide a segregation of forest ecosystems for different services such as production forests, protection forests but as well multipurpose forests where various services are provided at the same time. In this presentation the different options of forest management are described and there advantages and disadvantages for fulfilling the needs of society in an uncertain future are discussed.

Fungi associated with forest trees: friends or foes

Fred Asiegbu
Department of Forest Sciences, University of Helsinki, Helsinki, Finland

Fungi associated with forest trees play fundamental roles in the health of trees, influencing their vitality and productivity. Many of these fungi cause diseases while others prevent disease or enhance tree growth. Some fungi produce toxins dangerous to humans and domestic animals or spoil products in storage, while others (saprotrophs) cause problems by decaying construction wood and causing dry rot to buildings. However, some fungi are also necessary as saprotrophs for decaying organic matter and mineralization of nutrients and play a central role in carbon cycling in nature. At the other extreme are beneficial mycorrhizal fungi which play economically significant roles in the nutrition, growth and health of forest trees, and in nutrient cycling. Mycorrhizal, pathogenic and saprotrophic fungi share some common features but differ in the distinct ways in which the different types of interaction are induced and regulated. In this context, forest trees and the associated fungal partners share overlapping co-evolutionary life histories. The consequences range from latent endophytic relationship to mutualism or fatal pathogenic infections. In pathogenic infections, necrotrophic pathogens rapidly kill host cells and feed on their contents. In contrast, biotrophs feed on nutrients provided by living host cells over extended time and, therefore, depend on their integrity. Irrespective of their lifestyle and mode of infection, tree pathogens possess genes that are essential for causing disease or for increasing virulence on one or few hosts. I will highlight application of genomics in understanding forest fungi life forms and diversity. I will describe approaches that led to discovery of putative pathogenicity factors in the conifer tree pathogen (Heterobasidion annosum) and how this has facilitated our understanding of tree pathogenesis and activation of tree disease resistance. Finally, I will highlight strategies for the control and management of the conifer pathogen.

Session CSF-02 (88-1): The role of forestry society organizations in forestry innovation

Give full play to the role of forestry society organizations in scientific and technological innovation

Chen Xingliang
Chinese Society of Forestry, China

Society organizations is a highly autonomous social organization with the goal of scientific and technological innovation and communication. The emergence of society marks the progress of science and technology, marks the social development and the evolution of civilization. With the development of economic and social, society shows more and more unique features and their own charm. Throughout the development of science and technology in the world, society played a key role in scientific and technological innovation, and made a contribution which can't be destroyed. Forestry developed countries attach great importance to the role of forest society organizations, which promotes the forestry scientific and technological progress and innovation in a very active form. In the 21st century, China's forestry development attracts all the world's attention. To play the first driving force of innovation, and to play the first productive force of science and technology, we must give full play to the key role of forestry society organizations. Chinese Society of Forestry, with a 100-year history, has become a major force to promote scientific and technological progress in forestry. In the future, CSF will make further contribution to acting as a major force to promote forestry technological progress and innovation in the following ways: inspiring innovative ideas in science and technology and subjects, and giving full play to its role in scientific popularization, talent recommendation, consultation and decision-making, achievement transformation, international cooperation and periodical publication.

Success stories from canadian forests: national collaboration to advance innovations in the forest sector

Jonathan Lok, Dana Collins
Canadian Institute of Forestry

At 108 years old, The Canadian Institute of Forestry-Institut forestier du Canada (CIF-IFC) is the oldest forest conservation organization in Canada, serving to provide national leadership in forestry, promote competency in forest professionals, and foster public awareness on Canadian and international forestry issues. Through a diverse and interdisciplinary membership, and partnerships that transcend multiple sectors, the Institute networks some 10,000 forest practitioners and professionals, in addition to a significant contingent of the environmental conscious public. This framework provides a cost effective platform for the pooling of resources (human and financial), while proactively making science and research widely accessible and relevant. The Institute's successful track record in forest science extension, knowledge exchange and research, in conjunction with an array of well-connected partners and affiliates, has enabled for the CIF to become a national leader in forest science collaboration at local, provincial and national scales. Resultantly, through interdisciplinary peer-to-peer collaboration, the Institute and its partners have successfully and effectively catalyzed the implementation and application of sound forest science into policy, planning and practice to support sustainable forestry in Canada. Recent growth and diversity in both membership and partnerships at international scales has facilitated the development of multi-national knowledge exchange priorities.

Forestry innovation and the role of forestry NGO

A Rob de Fégely BSc (For), MSc
National President Institute of Foresters of Australia

The Institute of Foresters of Australia was founded over eighty years ago in 1935 and its aim has been to support professional forest managers throughout Australia and where possible provide a connection with similar forestry non-government organisations around the world. It is a non-government organization (NGO) and a not for profit with over 700 members in all states and territories of Australia and overseas. Members work in conservation and production forests across the Australian and international landscape from wilderness areas to plantations to agro-forestry, water catchments and urban forests. The forestry interests of our members are broad. We live in an ever changing world and forestry is no exception. When I started my career communication was by letter or courier, seven years later the facsimile machine arrived and by the early 1990's the first mobile phones appeared and email and the internet were in their formative years. Mapping was still done manually. Today my smartphone has more memory and processing capacity than my first computer which was purchased in the late 1980's for around AUD 8,000. While my university degree taught me to handle change, my membership of the Institute of Foresters has kept me abreast of new innovations in forest management. The level of innovation in the Australian forestry industry and the role of the Institute of Foresters will be discussed over a period of 36 years or essentially one rotation of Radiata pine. The innovation in computing and software design has allowed analysis and management efficiencies we could only dream of as young foresters. The role of the Forestry NGO in collecting and reporting research and general information on forest management will presented and discussed how this is published for members to comment, test and provide feedback. Some information may be controversial or even incorrect but the NGO has a role to provide a forum for views and it can do this relatively easily and inexpensively via its network so that members can continue to develop their professional skills. The Institute of Foresters of Australia operates a weekly news bulletin, a quarterly newsletter and a peer reviewed Journal which is the pinnacle publication for forestry research and innovation in Australia.

The society of American foresters: fostering innovation to benefit society

Richard W. Guldin, Clark W. Seely, Matthew Menashes, John stanturf
Society of American Foresters, Bethesda, Maryland, USA

The Society of American Foresters (SAF) was founded in 1900, with the objective "… to further the cause of forestry in America by fostering a spirit of comradeship among foresters; by creating opportunities for a free interchange of views on forestry and allied subjects; and by disseminating a knowledge of the purpose and achievements of forestry." (November 30, 1900). Simply put, the original focus of SAF was on people and on exchanging scientific knowledge and experiences about the purpose and practice of forestry on the ground. One-hundred sixteen years later, SAF is still about connecting people, advocating for science-based management, and creating and celebrating local forestry success stories. If SAF's objectives haven't changed, why is SAF still effective today? Organization theorists say that the older an organization becomes, the more it tends to become inwardly focused, doing things only for the benefit of the organization or its members. To remain creative, innovative, and growing, an organization must work very hard and deliberately at shifting from an inward focus to an outward focus on the needs of people outside the organization. Although it is an old organization, SAF continues to push hard on shifting its focus outward. Regarding people, SAF is not only looking for innovative ways to network better among our members, we are actively seeking to broaden our professional networks and relationships with members of other scientific and professional societies. Further, we aren't limiting our networking to those in the natural resources communities. We are also pushing to connect with people interested in cultural and social issues, such as environmental justice. Many social and cultural issues have ties to natural resource issues that aren't always clear. But SAF and its members know how important forests are to clean air, clean water, and quality of life for people throughout the United States and around the world. We are looking for ways to connect with and help people and groups interested in issues like these because we feel an obligation to help them and help society do better. Regarding science, SAF is looking for better ways to share science with people who are struggling to make good decisions. Publishing scientific journals remains important, but is too narrow a focus for professional societies today. SAF is moving into social media and other non-traditional ways to transfer the knowledge in our journals and the experiences of our members to people outside SAF who need us and our science and will benefit from it. Regarding local forestry success stories, SAF's local members are energetically and creatively developing new relationships with people and communities and working with them on local forestry projects. We are connecting young people to trees where they live, learn and play. Times and issues are changing, and forestry is evolving. SAF and its members are also evolving by focusing on people, communities, and issues beyond traditional forestry. Our successes demonstrate how we are fostering innovation to benefit society!

The role of the Korean forest society in forest innovation

Jung-Kee Choi
Korean Forest Society, Kangwon National University, Korea

Established in 1960, the Korean Forest Society is the representative society in the field of Korean forestry. Members consist of about 1,000 people including mainly the Korean Forest Service and affiliated organizations, the Forest Bureau and Institute of provinces, the National Forestry Cooperatives Federation, the Korean nursery association, and 21 forestry colleges.

Major businesses of the Korea Forest Society are publishing a journal, hosting academic conferences and symposia, granting Hyeon Shin-Gyu scholarship, publishing forestry books and performing research projects.

Moreover, it has been helping many students in the field of Forest Experience Education with the public, such as forest education for elementary, middle, and high school students, International Forest Summer Program for the forestry students, forest information education, and training overseas.

Henceforth, the Korean Forest Society plans to hold a joint academic symposium, exchange of forest education and information through MOU among Korea, Japan, and China Forest Society.

The activities of the Japanese forestry society in forestry innovation

Yasumasa Hirata
The Japanese Forest Society, Forestry and Forest Products Research Institute,
National Research and Development Agency

The Japanese Forest Society (JFS) is a scientific and professional organization founded in 1914, and has more than 2,000 individuals and institutional members. Today's environmental and resources problems range from local to global scales and indicate that forests play an essential role by regulating carbon, water, sediment, and nutrients flows, and by providing wood products, wildlife habitat, and recreational opportunities. The JFS's main objectives are to advance both forest science and forestry, to support human well-being and culture by identifying and solving environmental and resources problems, and to contribute to the sustainable development of human society. The JFS supports communication among members devoted to studying forest science and forestry issues, covering all aspects of an interdisciplinary science, including biology, ecology, hydrology, environmental science and socio-economy.

Session CSF-03 (88-3): Forest biological disaster control and sustainable management

Epidemic and control of pine wilt disease in China

Ye Jianren
Nanjing Forestry University

Pine wilt disease (PWD) caused by the pine pinewood nematode (PWN) Bursaphelenchus xylophilus is one of the most serious worldwide conifer diseases affecting pine trees (Pinus spp.). PWD was first reported in 1982 in Nanjing, China and has been spread rapidly to 280 counties in 17 provinces in the last three decades, resulting in huge economic and environmental losses. The estimated economic losses were 2.5 billion Chinese Yuan. The distribution area of PWD was located mainly in Jiangsu, Anhui and Zhejiang provinces, and one sub-area was in Guangdong province. Currently, PWN has reached most of the main areas (provinces) suitable for its survival, but with high variations in disease occurrence in different areas. For example, the disease has been much common in entire Jiangsu and Zhejiang provinces, but only found in part of the areas inYunnan and Guizhou provinces. About 30 million hectares of pine forest in southern China are susceptible to PWN. However, only less than 1% of the area was infected by PWN so far. The keys to successfully prevent and control PWD in China were the results of efficient management in PWD monitoring and quarantine, treatment of the diseased tree, control of the vector insect and protection of important pine forest. There is still long way to go for prevention and control PWD in China.

Development of tree resistance as a primary response to established invasions by tree killing forest pathogens and insects

David Showalter[1], Jason Smith[2], Kenneth Raffa[3], Richard Sniezko[4], Daniel Herms[1], Andrew Liebhold[4], Pierluigi Bonello[1]*
1. The Ohio State University
2. University of Florida
3. University of Wisconsin-Madison
4. USDA Forest Service

Massive global trade facilitates movement of tree-killing, alien phytophagous insects and phytopathogens (PIPs). It is becoming increasingly clear that some of the most economically and environmentally impactful alien PIPs become devastating due to the “defense-free space” they

find as they invade naïve forest environments. Such PIPs are often characterized by intimate and cryptic host association that makes early detection very difficult, and a lifestyle that leads to destruction of host tissue with high fitness value that cannot be easily compensated, thereby limiting the effectiveness of density-dependent biological control.
Using several case studies, we argue that once such PIPs become established, responses should immediately and sustainably transition forests toward a “defense-constrained space”, i.e. through the development of host resistance. Various combinations of traditional selection and breeding, rapidly advancing genomic and phenotypic marker-assisted selection, and targeted genetic engineering, offer great potential to accelerate development and deployment of diverse populations of locally-adapted, PIP-resistant trees.

Longhorned beetle pheromones and sustainable forest pest management

Stephen A. Teale
Departmrent of Environmental and Forest Biology, College of Environmental Science and Forestry, State University of New York

Longhorned beetles rank among the most serious threats to forest health in several parts of Asia. Many of these are native species that respond to conditions inadvertently created by human activities and interfere significantly with management objectives. Included in this group are Anoplophora chinensis, A. glabripennis, Aromia bungii, Apriona germari and Batocera horsfieldi. Additionally, the introduced pine wilt nematode which causes pine wilt disease is vectored by native Monochamus species especially M. alternatus in eastern Asian countries. These species are regarded as high risk pests with the potential to be introduced to other regions and continents. Chemical attractants including pheromones can form the basis of environmentally benign pest management. Recent advances in the pheromone biology and chemistry of longhorned beetles in Europe and North America have made it possible to exploit the conserved nature of longhorned beetle chemical ecology. Testing known pheromones from European and North American species in China has led to the successful identification of aggregation pheromones in several Asian species. These pheromones may be deployed in population detection and monitoring as well as population suppression tactics.

Potential distribution predicted for *Rhynchophorus ferrugineus* in China under different climate warming scenarios

Ge Xuezhen[1], Shanyong He[1], Tao Wang[2], Wei Yan[3], Shixiang Zong[1]
1. Beijing Forestry University
2. Mentougou Forestry Station
3. Chinese Academy of Tropical Agricultural Sciences

As the primary pest of palm trees, Rhynchophorus ferrugineus (Olivier) (Coleoptera: Curculionidae) has caused serious harm to palms since it first invaded China. The present study used CLIMEX 1.1 to predict the potential distribution of R. ferrugineus in China according to both current climate data (1981–2010) and future climate warming estimates based on simulated climate data for the 2020s (2011–2040) provided by the Tyndall Center for Climate Change Research (TYN SC 2.0). Additionally, the Ecoclimatic Index (EI) values calculated for different climatic conditions (current and future, as simulated by the B2 scenario) were compared. Areas with a suitable climate for R. ferrugineus distribution were located primarily in central China according to the current climate data, with the northern boundary of the distribution reaching to

40.1°N and including Tibet, north Sichuan, central Shaanxi, south Shanxi, and east Hebei. There was little difference in the potential distribution predicted by the four emission scenarios according to future climate warming estimates. The primary prediction under future climate warming models was that, compared with the current climate model, the number of highly favorable habitats would increase significantly and expand into northern China, whereas the number of both favorable and marginally favorable habitats would decrease. Contrast analysis of EI values suggested that climate change and the density of site distribution were the main effectors of the changes in EI values. These results will help to improve control measures, prevent the spread of this pest, and revise the targeted quarantine areas.

Endophytic bacterium Bacillus methylotrophicus strain HYEB5-6 as a potential biocontrol agent against anthracnose on Euonymus japonicus

Lin Huang[1], Qiu-Cheng Li[1], Yao Hou[1], Guo-Qian Li[1], Ji-Yun Yang[1], De-Wei Li[1, 2] and Jian-Ren Ye[1]

1. Co-Innovation Center for Sustainable Forestry in Southern China, Nanjing Forestry University; 2. The Connecticut Agricultural Experiment Station Valley Laboratory

Anthracnose is a disease of the Euonymus shrub caused by Colletotrichum gloeosporioides on the leaves. In this study, the endophytic bacterium HYEB5-6 was isolated from inside one-year-old branches of healthy E. *japonicus* and showed significant antifungal activities against various phytopathogenic fungi, including C. *gloeosporioides* s.s. HYCG2-3, on the dual culture plates. The HYEB5-6 isolate significantly decreased the lesion diameter and disease index caused by C. *gloeosporioides* inoculation on detached leaves of E. *japonicus*. The effects of HYEB5-6 metabolites on the invading structure of the fungus were investigated. The results showed that the metabolites inhibited conidial germination, the growth of the germ tube and appressorium formation, possibly through protease and glucanase of HYEB5-6 by managing the mycelial cell wall. The HYEB5-6 isolate also produced a massive biofilm, which might facilitate leaf colonization. These results indicated that HYEB5-6 has the potential for use as a biological control agent against C. *gloeosporioides*. The HYEB5-6 isolate was identified as *Bacillus methylotrophicus* based on its biochemical and physiological characteristics and its 16S rRNA gene sequence.

Antennal transcriptome analysis of the Asian longhorned beetle Anoplophora glabripennis

Ping Hu, Jing Tao, Youqing Luo

Beijing Forestry University

Olfactory proteins form the basis of insect olfactory recognition, which is crucial for host identification, mating, and oviposition. Using transcriptome analysis of Anoplophora glabripennis antenna, we identified 42 odorant-binding proteins (OBPs), 12 chemosensory proteins (CSPs), 14 pheromone-degrading enzymes (PDEs), 1 odorant-degrading enzymes (ODE)，37 odorant receptors (ORs), 11 gustatory receptors (GRs), 2 sensory neuron membrane proteins (SNMPs), and 4 ionotropic receptor (IR). All CSPs and PBPs were expressed in antennae, confirming the authenticity of the transcriptome data. CSP expression profiles showed that AglaCSP3, AglaCSP6, and AglaCSP12 were expressed preferentially in maxillary palps and AglaCSP7 and AglaCSP9 were strongly expressed in antennae. The vast majority of CSPs were highly expressed in multiple chemosensory tissues, suggesting their participation in olfactory recognition in almost all olfactory tissues. Intriguingly, the PBP AglaPBP2 was preferentially expressed in antenna, indicating that it is the main protein involved in efficient and sensitive pheromone recognition. Phylogenetic analysis of olfactory proteins indicated AglaGR1 may detect CO2. This study establishes a foundation for determining the chemoreception molecular mechanisms of A. glabripennis, which would provide a new perspective for controlling pest populations, especially those of borers.

Effects of endobacterium (Stenotrophomonas maltophilia) on pathogenesis-related gene expression of pine wood nematode (*Bursaphelenchus xylophilus*) and pine wilt disease

Long-Xi He[1,2,3], Xiao-Qin Wu[1,2], Qi Xue[1,2], Xiu-Wen Qiu[4]

1. Co-Innovation Center for Sustainable Forestry in Southern China, College of Forestry, Nanjing Forestry University

2. Jiangsu Key Laboratory for Prevention and Management of Invasive Species, Nanjing Forestry University

3. Jiangxi Forest Pest Control and Quarantine Bureau

4. Poyang Lake Eco-economy Research Center, Jiujiang University

Pine wilt disease (PWD) caused by the pine wood nematode (PWN), Bursaphelenchus xylophilus, is responsible for devastating epidemics in pine trees in Asia andEurope. Recent studies showed that bacteria carried by the PWN might be involved in PWD. However, the molecular mechanism of the interaction between bacteria and the PWN remained unclear. In this study, the transcriptome of aseptic B. xylophilus, B. xylophilus treated with endobacterium (Stenotrophomonas maltophilia NSPmBx03) and fungus B. xylophilus were sequenced. We found that 61 genes were up-regulated and 830 were down-regulated in B. xylophilus after treatment with the endobacterium; 178 genes were up-regulated and 1122 were down-regulated in fungus B. xylophilus compared with aseptic B. xylophilus. Many pathogenesis-related genes, including glutathinone S-transferase, pectate lyase, ATP-binding cassette transporter and cytochrome P450, were up-regulated after B. xylophilus were treated with the endobacterium. In addition, we found that bacteria enhanced the virulence of PWN. These findings indicate that endobacteria might play an important role in the development and virulence of PWN and will improve our understanding of the regulatory mechanisms involved in the interaction between bacteria and the PWN.

Establishment and evaluation of a loop-mediated isothermal amplification assay for detection of Phytophthora cinnamomi

Dai Tingting, Wu Xiaoqin

Nanjing forestry university

Damage caused by Phytophthora cinnamomi Rands remains an important concern on forest tree species. Pathogen identification based on morphology or PCR analysis is time-consuming. In this research, a molecular differential detection system with Loop-mediated isothermal amplification (LAMP) was developed and applied for the detection of P. cinnamomi. A new target was identified in the genomic structure analysis of Phytophthora spp. Bioinformatica analysis indicated that this sequence was suitable for detecting P. cinnamomi. The specificity of the method was tested against P. cinnamomi, Phytophthora spp., Pythium spp., and true fungi. With the addition of hydroxynaphthol blue (HNB) prior to amplification, a sky-blue color was only observed in the presence of P. cinnamomi, whereas other isolates showed no color change. The method was sensitive enough to detect as little as 100 pg/uL fungal DNA. In addition, the assay

also detected P. cinnamomi from diseased tissues and residues. It could be potentially applied to detection of DNA of pathogens in poor-equipped laboratories. Establishment of LAMP method provides a new alternative method for the rapid detection of Phytophthora cinnamomi diagnostics.

Pathogenicity of Bursaphelenchus mucronatus isolates to pine trees and their preliminary proteomics studies during the pathogenic processes

Zhou Lifeng[1], Chen Fengmao[1], Pan Hongyang [2], Ye Jianren[1]
1. Nanjing Forestry University
2. General Station of Forest Pest Management

Bursaphelenchus mucronatus has generally been considered to be non-pathogenic to pine, but it has been isolated from dead pine trees in some provinces of China. Previous studies have shown that B. *mucronatus* can induce the death of pine seedlings under greenhouse conditions. To investigate the virulence of B. *mucronatus*, 2-year-old seedlings of *Pinus massoniana* and *Pinus elliottii*, and 12-year-old Pinus thunbergii were inoculated with different isolates under field conditions. The results shown that B. *mucronatus* isolates that originate from different regions may vary in their virulence, but their virulence-associated proteins are poorly understood. Thus, we conducted an iTRAQ to analyse the proteomic profiles of highly and weakly virulent B. *mucronatus* isolates during the pathogenic processes. More than 5,000 proteins were obtained from the isolates. A functional analysis showed that five differentially expressed proteins which were all highly expressed in the highly virulent isolate were involved in the pathogenic processes of nematodes. Three of them relate to resistance against plant defence responses, while the other two are associated with the breakdown of plant cell walls. Our work adds to the understanding of B. *mucronatus*' pathogenesis, and will aid in controlling B. *mucronatus* and other pinewood nematode species complexes in the future.

Community and functional diversity of bacteria associated with Pine Wood Nematode Bursaphelenchus xylophilus in propagative and dispersal forms

Wu Xiaoqin[1,2], Xue Qi [1,2], Xiang Yang[1,2], Ding Xiaolei[1,2], Xu Xiaolu[1,2], Ye Jianren[1,2]
1. Co-Innovation Center for Sustainable Forestry in Southern China, College of Forestry, Nanjing Forestry University
2. Jiangsu Key Laboratory for Prevention and Management of Invasive Species, Nanjing Forestry University

Pine wilt disease, caused by pine wood nematode (PWN) Bursaphelenchus xylophilus, is a devastating disease in pine forests. Bursaphelenchus xylophilus has propagative and dispersal forms in its life cycle, which is correlated to the life cycle of the insect vector Monochamus alternatus. PWN-associated bacteria have been reported to play a role in process of pine wild disease. However participation of these bacteria in the transformation of nematodes life cycle has not been reported. In this study, the diversity and population dynamics of bacteria associated with propagative and dispersal PWN were analyzed using cultural and Biolog methods coupled with high-throughput sequencing. The results revealed that Stenotrophomonas, the culturable endo-bacteria of PWN in diseased pine was not found in PWN carried by M. alternatus. Endo-bacteria in dispersal PWN carried by M. alternatus showed the highest total carbon utilization. The high-throughput analysis showed that Stenotrophomonas, Achromobacter and Sphingobacterium were more abundant in propagative PWN than in dispersal PWN, whereas Citrobacter, Vibrio and Enterobacteriaceae were more abundant in dispersal PWN. It indicates that bacteria associated with PWN in different developmental forms were different. This change of PWN-associated bacteria might help PWN to adapt the changing environment.

Identification and expression pattern analysis of Pheromone binding proteins gene AglaPBP1 and AglaPBP2 in the *Anoplophora glabripennis* (Coleoptera: Cerambycidae)

Wang Jingzhen
Beijing Forestry University

This study aims to identify the pheromone binding proteins genes of the Anoplophora glabripennis (Motsch.) and detect tissue-differential expression of two PBPs both in male and female. To identify the pheromone binding proteins genes, two PBPs genes fragment was obtained by blast based on antennal transcriptome we have established. By cloning and sequencing we obtained the complete sequences and then bioinformatic methods were also employed. Real-time PCR were employed to detect expression pattern of PBPs gene in different sexes. Two PBPs genes were obtained from A. glabripennis and named as AglaPBP1 (Gen Bank accession no.KX272639) and AglaPBP2 (Gen Bank accession no.KX272640). The open reading frame in AglaPBP1 is 411bp, encoding 136 amino acid residues with the predicted molecular weight and the isoelectric point of 15.02 kDa and 4.22 respectively. The open reading frame in AglaPBP2 is 408bp, encoding 135 amino acid residues with the predicted molecular weight and the isoelectric point of 15.007kDa and 5.16 respectively. AglaPBP1 and AglaPBP2 all have signal peptide in 1-21 and 1-19. Both AglaPBP1 and AglaPBP2 were characterized by six conservative cysteine (Cys) residues. The AglaPBP1 and AglaPBP2 had about 74% and 49% identity with PBPs from Batocera horsfieldi (Hope). qPCR analysis indicated that AglaPBP1 was expressed in antennae , maxillary palp and Leg, and female antennae expression was higher than male. While AglaPBP2 was almost specific expressed in male antennae. Clearing AglaPBP1 and AglaPBP2 expression in different parts lays a foundation of further study for function and clears the molecular mechanism of insect smell identification.

Deciphering the molecular variations of pine wood nematode Bursaphelenchus xylophilus with different virulence

Ding Xiaolei
Institue of Forest protection, Nanjing Forestry University

Bursaphelenchus xylophilus is the causative agent of pine wilt disease which has caused huge economic losses in many countries. It has been reported that two forms of pine wood nematodes existed in its native region, i.e., with strong virulence and weak virulence. However, little is known about the molecular differences between the two forms. To better understand their molecular variations, transcript me and genome sequences of three strongly virulent and one weakly virulent strains were analyzed. We found 238 transcripts and 84 exons which showed notable changes between the two virulent forms. Functional analyses of both differentially expressed transcripts and exons indicated that different virulence strains showed dissimilar nematode growth, reproduction, and oxidoreductase activities. In addition, we also detected a small number of exon-skipping events in B. xylophilus. Meanwhile, 117 SNPs were identified as potential genetic markers in distinguishing the two forms. Four of them were further proved to have undergone allele specific expressions and possibly interrupted the target site of evolutionary conserved B. *xylophilus* miR-47. These particular SNPs were experimentally verified by including eight additional strains to ensure the validity of our sequencing results. These results could help researchers to better diagnose nematode species with different virulence and facilitate the control of pine wilt disease.

Invasion risk analysis of Plum pox virus to China

Lin Sixi, Ding Xiaolei,Ye Jianren
Institue of Forest protection, Nanjing Forestry University

Plum pox virus could infect most Prunus trees and causes the decrease of fruit quality. This report predicted the potential distribution of Plum pox virus in China using the maximum entropy (Maxent) ecological niche models combined with geographic information system (Arc GIS) based on its current distribution and the environment variables of target region, which divided the territory into four parts: high suitable region, medium suitable region, low suitable region and unsuitable region. The results of ROC (Receiver operating characteristic curve) evaluation showed that both the training data and testing data of Plum pox virus' potential distribution had very good performances because their AUC (areas under curve) were 0.966 and 0.959 respectively. From 5 aspects of the possibility of incoming, colonization, diffusion, the victim host economic importance and difficulty of risk management, including 18 indicators, this article has carried the virus invasion risk analysis on the qualitative and quantitative level with the standard of integrated multi index evaluation system. The results showed that the potential distribution of Plum pox virus mainly located in the eastern and southern China. Since its scattered distribution in China, strict quarantine measures include both serological and molecular biological detection was absolutely necessary. And more than 2 years isolated planting were also required to prevent the further spreading to other places.

Supercooling capacity and cryoprotectants of overwintering larvae from different populations of *Holcocerus hippophaecolus*

Tian Bin
Beijing Key Laboratory for Forest Pest Control, Beijing Forestry University

Holcocerus hippophaecolus is the most serious pest occurred in *seabuckthorn* forest of three north areas. OBJECTIVE: The primary aims of the current study were to explore the physiological mechanisms and adaptability of H. *hippophaecolus* to low temperatures. Assessing supercoiling point, freezing point, and cry protectants of different larval instars from three different populations. Supercoiling capacity of larvae from the 8–13 instar groups was relatively independent of temperature and other indicators such as latitude. Larvae from the 14–16 instar groups were sensitive to temperature and latitude, with generally lower limits and a wider range of SCPs than those of the other instar groups. For each population, the differences in the supercoiling capacity of different instar stages for the identical period were not significant. The metabolism of fat and glycogen might not be the primary factors affecting the supercoiling capacity.

A clarifying revision scientific name and damage features of *Agrilus subrobustus Saunders*

Hong Zhang
Beijing Forestry University

We researched on the morphological characteristic and damage features of *Agrilus subrobustus*

Saunders, one species of the buprestid beetles frequently caused severe damage on silk trees (*Albizia julibrissin Durazz*), and explored the three dimension reconstructions of its galleries. Our work would provide guidance and suggestions for the monitoring and preventive treatment of this pest. Based on previous literatures, we revised the changing process of its scientific name, detailedly observed and described the morphological characteristics of its adults, pupae, larvae and eggs inside the oviducts. Geometric indexes of A. *subrobustus*'s boring gallery were analyzed for the first time, including population density, length and width of the galleries, as well as characters of the entrance hole, the pupal chamber, and the emergence hole. The morphology and the regularity of the occurrence and development of A. *subrobustus*'s complete boring galleries were analyzed accordingly. Based on gallery photographs and geometric vector indexes, equal proportion accurate drawings were made; three dimension reconstructions of the galleries were completed by Autodesk Maya. The larvae of A. *subrobustus* were ivory and slender. Its pupae belonged to the exarate type. The adults were shiny and greenish. The adult morphology characters including pronotum shape (length versus width), pronotum disk, prehumerus, metasternal projection, elytra pubescence distribution and the aedeagus were observed. Through detailed comparision and consulting literature, the scientific name was clarified. A. *subrobustus* damaged both the phloem and xylem of A. *julibrissin*, and were active at the sunny side of the hosts. A. *subrobustus* bored galleries under barks of hosts, with round shaped entrance hole measuring less than 1mm. The pupal chambers were oval shaped, most of them distributed in the xylem of the host, minorities were in the phloem. The emergence holes were"D"shaped. Generally the boring galleries could be divided into three types by the morphology characters:"Z"shaped or its extended type, vertically roundabout type and ellipse or semicircle type. The morphological character description and clarification of the scientific name of A. *subrobustus* would help with future identification of the beetle. The three dimension gallery reconstruction would guide the recognition of the beetle and its damage grades during non-adult stages, and provide technical guidance for the pest monitoring and control.

A comparative study of the abdominal trichobothria in the Trichophora, with emphasis on Lygaeoidea (Insecta: Hemiptera: Heteroptera)

Gao Cuiqing[1], Dávid RÉDEI[2], Xueqin SHI[2], Cai Bo[3], Bu Wenjun[2]
1. Southern Modern Forestry Collaborative Innovation Center, College of Foresty, Nanjing Forestry University, Nanjing, 210037, China
2. College of Life Sciences, Nankai University, Tianjin, 300071, China
3. Post-Entry Quarantine Station for Tropical Plant, Hainan Entry-Exit Inspection and Quarantine Bureau, Hainan, 570311, China

Members of the clade Trichophora (Hemiptera: Heteroptera: Pentatomomorpha) possess trichobothria on the abdominal sterna. The fine structure of abdominal trichobothria was never studied comparatively across Trichophora, and that in immature stages has remained virtually unknown so far. The cuticular fine structure of the abdominal trichobothrial complex (=the trichobothrium and its associated structures) of adults of 96 species representing 24 families in 5 superfamilies, and larvae of 7 species representing 7 families in 2 superfamilies of Trichophora were examined by scanning electron microscopy. The results of this study indicate that the cuticular fine structure of abdominal trichobothria is diversified and can be used as a character of taxonomic importance and valuable in recognizing evolutionary lineages within Trichophora. Six types of bothria, three types of trachoma and three types of microtrichia are recognized. Thirteen types of trichobothrial complex are recognized too. The examined trichophoran larvae possessed trichobothria of the same type as the conspecific adults, nevertheless, differences were observed

in the size of the trichoma, the density and the size of the microtrichia. The distributional patterns of different lengths of trichs on abdomen were illustrated too.

A new pathogen of stem canker on *Sophora japonica* f. pendula Hort.

Yang Jiyun, Li Qiucheng, Zhang Ya, Ye Jianren, Huang Lin
Co-Innovation Center for Sustainable Forestry in Southern China, College of Forestry, Nanjing Forestry University

As one of nice tree species for landscape engineering and raw material for development of traditional Chinese medicine, Sophora japonica f. pendula Hort. is widely cultivated in China. In recent years, a stem canker disease are observed in the branches around twig buds and lenticels of Sophora japonica f. pendula Hort., however, the pathogen of this disease is not clear yet. In this study, the fungal isolate F6 isolated from symptomatic tissue, and was determined by Koch's Postulates to be a pathogen of the stem canker. Morphological observation showed microconidia of isolate F6 were oval to kidney shaped, single celled, 3.0 to 5.5 × 1.2 to 3.1μm. Macroconidia were two to five septate, cylindrical to slightly curved, with characteristic foot shaped basal cell and blunt apical cell, 9.1 to 21.9 × 1.8 to 3.4μm. Chlaymydospores were missing. Based on fungal reference of Leslie et al. (2006), the isolate were identified as *Fusarium solani* (Corda) Sacc. Analysis of the ITS sequence of F6 isolate (GenBank Accession No. KX641463) using BLASTn revealed a 99% sequence identity with F. *solani* strain (FJ874633). Phylogenetic tree of ITS sequences also showed isolated F6 and other F. *solani* species complex strains were monophyletic, with significantly higher bootstrap support. Based on these morphological and molecular evidences, isolate F6 was identified as F. *solani*. To our knowledge, this is the first report of F. *solani* causing stem canker on Sophora japonica f. *pendula* Hort. in China.

Assessment of micro-ecological effect of *Burkholderia pyrrocinia* JK-SH007E1 on microbial communities in rhizosphere soil of poplar

He Lingmin[1,2], Ye Jianren[1,2], Wu Binyan[1,2], Huang Lin[1,2], Ren Jiahong[3], Wu Xiaoqin[1,2]
1. Southern China Collaborative Innovation Center of Sustainable Forestry, College of Forestry, Nanjing Forestry University;
2. College of Forestry, Nanjing Forestry University;
3. Department of Biology Science and Technology, Changzhi College

Comparing with wild bacteria, the engineered bacteria would have stronger biocontrol ability and wider application prospect on the biocontrol of agricultural and forest pests. The environmental release of the engineered bacteria may have an effect on diversity and function of soil ecosystem. Therefore, it is important and necessary to assess the biosafety of engineered bacteria *Burkholderia pyrrocinia* JK-SH007E1 before its release to natural environment. In this study, the micro-ecological effects of JK-SH007E1 on the soil microorganisms were investigated from three aspects. Firstly, the Biolog EcoPlate was used to detect the functional diversity of microbial communities in rhizosphere soil of poplar (RSP). Secondly, potential effects of JK-SH007E1 on four crucial soil enzyme activities of RSP were measured. Thirdly, 16S rRNA sequencing was conducted to investigate the species diversity and population structure of soil microbial communities. We found that JK-SH007E1 had certain positive effects on functional diversity, soil enzyme activity and alpha diversity of soil microbial communities, but the positive effects were attenuated over time except soil enzyme activities. The results demonstrated that release of

JK-SH007E1 to poplar seedlings had little or no threat on the soil microorganisms communities in the long term.

Effects of exogenous methyl jasmonate induced resistance in Populus × euramericana 'Nanlin895' on *Clostera anachoreta* performance and *metabolic enzyme activities*

Gu Tianzi[1,2], Zhang Congcong[1,2], Chen Changyu[1,2], Li hui[1,2], Huang kairu[1,2], Tian Shuo[1,2], Zhao Xudong[1,2], Hao Dejun [1,2]

1. Co-Innovation Center for the Sustainable Forestry in Southern China, Nanjing Forestry University;

2. College of Forestry, Nanjing Forestry University

Methyl jasmonate (MeJA) is a plant chemical elicitor that has been used to artificially induce chemical defense responses and trigger induced resistance against a broad range of arthropod herbivores. This study assessed the effects of exogenous MeJA on *Clostera anachoreta* growth performance, chemical detoxification, and antioxidant enzyme activities. After feeding C. *anachoreta* with 10‒5 mol/L MeJA solution treated Populus × euramericana 'Nanlin895' leaves, we measured the larval and pupal development time, pupal weight, eclosion rate, fecundity, and nutritional physiology of the adults. We also measured superoxide dismutase (SOD), catalase (CAT), and peroxidase (POD) activities, which are reactive oxygen species (ROS) scavengers, and glutathione-S-transferase (GST) and carboxylesterase (CarE) activities, which are probably involved in the metabolism of induced plant allelochemicals. Generally, methyl jasmonate (MeJA) treatment reduced larval performance in terms of prolonged developmental time and decreased growth rates, but had little effect on larval nutrition and growth. The activities of the SOD and POD antioxidant enzymes increased, but CAT activity declined at 36 h and 48 h after C. *anachoreta* had been feeding on MeJA-treated leaves. The GST and CarE detoxification enzymes were both induced after the larvae had fed on MeJA treated leaves. These results suggest that exogenous application of MeJAelicited induced resistancein Populus × euramericana 'Nanlin895'againstC. *anachoreta*.

The relationship between the ability of multiplication and migration and virulence of the pine wood nematode, *Bursaphelenchus xylophilus*

Jiang Peng, Zhu Lihua

Co-Innovation Center for Sustainable Forestry in Southern China, Nanjing Forestry University

To understand the mechanisms of pathogenicity of *Bursaphelenchus xylophilus*, two virulent isolates and two avirulent isolates of B. *xylophilus* were used to investigate the relationships between migrations, multiplications and virulence. Two-year-old seedlings of *Pinus thunbergii* and P. *massoniana*, 5-cm long 1-year-old stem cuttings of 2-year-old P. *thunbergii* and P. taeda were used to study the migration and multiplication of B. *xylophilus* after inoculation. The in-vitro migration rate of virulent B. *xylophilus* through stem cuttings were significantly different from that of avirulent isolates. The proliferation rate of virulent B. *xylophilus* on mycelial mats of Botrytis cinerea was also significantly different from that of avirulent isolates. The study using 2-year-old P. *thunbergii* seedlings and P. *massoniana* showed that virulent isolates kill all the seedlings in weeks, while avirulent isolates only wilted few seedlings months later. The populations of virulent B. *xylophilus* remaining in the pine seedlings were significantly larger than those of avirulent isolates. Therefore, we concluded that the pathogenicity of B. *xylophilus* could be influenced by its ability of migrations and multiplication.

Determination of Neck Blight Diseases Pathogen of Calotropis gigantean and its Biological Characteristics in dry-hot valley

Wu Jianrong
Southwest Forestry University

Calotropis gigantea have both textiles, medicinal, biologics development value. So it was planted by large-scale intensive in the dry hot valley region. Due to tree species, age structure is single, the disease was large-scale epidemics. The paper was study on neck blight diseases symptoms by the pathogen morphology observation and pathogen ribosomal DNA sequence analysis, causing neck blight diseases pathogen was Diaporthe citri, asexual generation quasi Phomopsis citri, pathogenicity test showed that mudar was Diaporthe citri another host. The optimum carbon source of the pathogen growth was glucose. The mycelium growth of the pathogen was obviously inhibited by nitrogen sources and vitamin. In PDA substrate, the preference temperature for mycelium growth was 15- 35oC, and the optimum temperature 30oC and pH 5-6 Conidia could only germinate at the relative humidity of 98%.

Olfactory response of Dastarcus helophoroides sharp to the volatiles emitted from hosts, their habitat, and volatile component analysis by GC-MS

Gao Yue
Forestry Academy of Jiangsu

The olfactory response of Dastarcus helophoroides Sharp to different volatiles from 3 species hosts and 2 species hosts' habitats, both healthy and bored, was measured by using a four-armed olfactometer in the laboratory. By gas chro-matography-mass spectrometry (GC-MS), we analyzed the volatiles from 3 hosts ' extraction with dichloromethane and ethe. The results indicated that the retention time of D. helophoroides in the treatment area with 25 or 50 mg / mL volatile from Monochamus alternatus was significantly longer than that in CK; Its retention time and entry number in the treatment area with both 25 and 50 mg / mL volatile from Saperda populnea were significantly more than those in CK, but significantly more than those in CK with only 50 mg / mL volatile from Zophobas morio. Its olfactory response to the hosts'bored habitat was shown preferably, with more inclination to hosts'Pinus thunbergii than Populus tomentosa habitat. GC-MS analysis showed many active components in the volatiles, with main peak values from 10 to 40 min at GC-MS graph , including linear paraf-fins (C21 - C36), aliphatic acids and their derivatives, terpenes, alcohols, ketones and phenols.

Propagation of an endangered gymnosperm tree species (Podocarpus neriifolius D. Don.) by stem cuttings in non-mist propagator

Md Aktar Hossain[1], Mohammad Ashraful Islam[1],
Md. Abul Kalam Azad[1], Mohammad Mahfuzur Rahman[2]
1. University of Chittagong,
2. Univercity ofChittagong

Podocrpus neriifolius D. Don. (Podocarpaceae) is an endangered indigenous gymnosperm tree species naturally occurs in Bangladesh. Due to inadequate number of mother trees and irregular seed setting from the few dioecious trees scattered throughout the country, propagation of the species through seed germination is impractical. Present study explores the multiplication potentials of this endangered tree species through rejuvenated stem cuttings with or without rooting hormone, IBA. Cutting bases were treated with 0%, 0.2%, 0.4% and 0.8% (w/v) IBA solution prior to setting in low cost, non-mist propagation system for rooting. Steckling performances of the rooted cuttings were evaluated in the nursery conditions. The study found that the species is hardto-root but amenable for rooting with IBA treatments. The highest rooting percentage and number of root per cutting were obtained from the 0.8% IBA treatment, but the longest root and shoot, as well as the initial growth performances were observed in the 0.4% IBA treatment. Therefore, rejuvenated stem cuttings treated with 0.4% IBA solution and rooting in non-mist propagator could be one of the effective methods for the vegetative propagation of this valuable, yet threatened tree species.

The social valorization of Cola nitida (Vent.) is threaten its conservation in Southern Benin (West Africa)

Merveille Koissi SAVI
Laboratory of Applied Ecology

Cola nitida, is tropical tree West Africa broadly known in pharmacology and ethnomedicine. Literature review showed that in Benin species omnipresence in every ceremony. It is resulted a weak documented social species valorization and the impact of this valorization on species sustainability in its habitats. This paper aims at assess (1) the local knowledge pattern within rural communities (2) the most use part for social valorization (3) the impact of valorization by harvesting on the species distribution. The objective (1) and (2) were reached using semi structural survey of 170 people in Adjarra, Sakété and Ouèdo. Data collected were used to compute some ethnobotanical indexes. The impact of species valorization was assessed through analysis of species diametric pattern obtained from 38 plots set in the species natural habitats. The results showed the unequal repartition of species knowledge according to genders. Actually, male possesses a broad knowledge than women. The most important part of species was the seed. The diametric structure gave bell shape indicating the weak regeneration. Thus the species social valorization is preventing species from recruitments. Hence, species domestication is needed to slow down upcoming species disappearance.

Land use change and local perception on management of Gnanhouizounmè forest (southern Benin)

Guillaume Houndemikon[1,2], Merveille Savi[1,2], Thierry Houehanou[1,2], Elysabette Dossou[3], Marcel Houinato[2]
1. Organisation pour le Developpement Durable et la Biodiversité
2. Laboratory of Ecology Applied
3. Ecole Régionale Post-universitaire dAménagement et de Gestion Intégrée des Forêts et Territoire Tropicaux

I conducted a study in the Gnanhouizoumè forest (97 ha) in Benin (6°52'- 6° 55' N, 2° 20' -2° 30' E) to evaluate the durability of the forest management method. Gnanhouizoumè Forest has great diversities of plant and animal species that need conservation efforts. I used systemic and integrated analysis and diachronic methods. The duration of my study is 6 months. Individual interviews and focus groups have been done. After using Dagnelie formula, 70 people have been interviewed. Many actors are involved in the forest management. This study showed us that Government structures are less active. The participative management comity of the forest (COGEPAF) is the most active. 76.79% of investigated people recognize its existence. It hosts

many Non-Governmental Organizations (NGOs) involved in forest management. Before the NGOs (CERGET, CIPCRE, and OBDD) arrived, the old wise had settled a local mode of management. But this is getting more and more ineffective due to the demographic growth. The Gnanhouizoumè populations continue depend on the resources of the forest. The main resources they obtain are firewood, construction wood, game, straw and cords. Human pressure is held responsible of deforestation. Land occupation maps generated by diachronic studies in 1982, 1996 and 2009's show that deforestation at Gnanhouizounmè Forest has been occurring at 0.73% per year. Natural formations are being displaced by human made ones. Ecotourism could help populations to turn from activities preventing a sustainable management of the forest. However lack of adequate infrastructures is an impediment for tourism development. Remaining issues that need investigation at this forest are the extent of faunal biodiversity including primate species richness, studies of primate feeding behavior, and sustainability of ecotourism

Intelligent robotics system for wildfire detection

Sham Pui Sum
Insight Robotics Ltd

This paper describes the design of an innovative forest fire detection system. The System integrates imagery and sensory data from the field to generate reliable data useful for monitoring large forests with complex terrain. And The System drastically improved reliability and successful rate of wildfire detection in rural areas. Robustness of the system allow it to be installed in remote areas that are not suitable to station human for safety and logistics concerns.

Session CSF-04 (88-2A), CSF-05 (88-2B): Multi-functional forest and multi-functional forestry

The complex interrelations among forest services and realization approaches of multifunctional forest management and forestry development

Wang Yanhui, Yu Pengtao, Hao Jia, Xiong Wei, Xu Lihong
Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

Forests supply multiple services (positive functions) for sustainable development. However, this supply, although increasing by new afforestation, is far below the quick increase of services demand since the rapid economy and population growth. This forced us to change the traditional forestry development and forest management from the separated use and evaluation of forest services into a holistic or multifunctional way. In this paper, the complex interrelations among forest functions were summarized as: 1) most functions can be spatio-temporally overlapped; 2) however, they are not always consistent for serving the mankind, but even competitive with each other; 3) they can be divided into dominant one(s) and others according to their importance to the mankind, but all should be fully used. 4) the relation among functions have a large spatio-temporal variation according to natural, social and economic conditions; 5) therefore, the techniques and policies required should be regional and site specific. Then the definition, principles and approaches of multifunctional forestry were discussed, with some cases in scales from forest stand to watershed, based on the long-term eco-hydrological study in the Northwestern China where water supply security and erosion control are the dominant services demands.

Integrated sustainable multiple-use forestry - designed for a national strategy & planning program and ISO-certified monitoring & evaluation

Alfred Pitterle
University of Natural Resources and Life Sciences

Forestry represents a very complex management activity, which is driven by clear goals, suitable management activities, proper technical tools and well educated experts. Goals have to reflect first of all the local site conditions and secondly the human interests. These multiple-use goals have to be clearly quantified by mathematic algorithms based on reliable criteria and indicators, in order to be identifiable in nature by a multiple-use inventory (by single-use maximized capacity, single-use sustainably optimized capacity, multiple-use sustainably optimized capacity). Sustainability always is closely related to the natural potential vegetation/forest type as the most stable and resilient ecosystem on the long run and also has to be recorded comparatively. All management activities have to be well adapted not only to the forest ecosystem itself but integratively also to all other interactively linked neighbouring ecosystems and/or human systems and have to be based on suitable environmentally tolerant technologies and tools. If all forest management components are born by measurable criteria & indicators a national strategy as well as country-wide program (targeting PPP-Projects) - all based on ISO-17065 certification standard - can be designed on political level and a ISO-9001 & 14001 monitoring & evaluation system can make sure a sustainable quality control to environmental and human benchmarks. An overall technology has been developed to meet all these pre-conditions.

From forest hydrological principles to forestry policies: lost in translation?

Ge Sun, Steven McNulty, James Vose
USDA Forest Service Southern Research Station

The science of forest hydrology is rooted in understanding how forests affect flooding and erosion and how forest management practices affect and protect water resources and other ecosystem services. Over the past century, forest hydrological science has advanced significantly due to 'paired watershed' vegetation manipulation experiments around the globe and the development of other sciences and technology such as remote sensing, computer simulation modeling, and biometeorology. Forest hydrologists now have the capability to quantify water fluxes from leaf, single tree, hillslope to landscape scales, and even the entire globe using satellite observations. As such, we know that forests are integral parts of watersheds and changes in forest cover have significant impacts on water quantity, quality, and timing of streamflow. However, there remains significant challenges in translating hydrological principles into forest management practices that can meet the increasing demanded for multiple ecosystem services such as carbon sequestration and clean water supply. Hydrologists, foresters, water managers, the public, and policy makers often have different perceptions of the complex forest-water relationships. Differences result from several factors: incomplete knowledge of forest hydrological science for novel conditions, the spatial and temporal scales of management issues, complex tradeoffs among objectives of modern forestry, lack of communications among scientists and practitioners in the scientific research and policy making cycles. The paper will present examples using studies from the U.S. and China to illustrate how best to apply forest hydrological principles to confront emerging environmental threats such as watershed degradation and climate change.

Multifunctional land use: management in an operational balanced setting

Zhang Lulu, Kai Schwaerzel
United Nations University

Land has to provide a number of ecosystem services for the local and adjacent areas, among which food production, soil conservation and water availability are the most important ones in the dryland environment. However, silos and sectors are still the dominant feature of land management in China (e.g., on the Loess Plateau region) leading to declining of certain ecosystem services (e.g., water availability). To reverse this trend, multiple use of land shall be improved by soil and water management covering reducing erosion and associated surface runoff and soil evaporation, as well as increasing and maintaining soil quality, this in turn, will increase water infiltration to allow more water available for root zone and underground aquifer. Furthermore, they are also beneficial for the users of adjacent areas in view of replenishment of groundwater, regulation of river flow and sediment. A possible way towards practical application of multifunctionality in ecosystems is to put emphasis on the nexus of resources, such as soil, water, waste. Different from sectoral integrated management concepts, such approach aims to increase resource efficiency and promote the overall shared benefits (human and environment) as it takes relationships, interactions, and interdependencies across sectors into consideration.

Forest trends by major challenges: the French 20-year experience on indicators of sustainable forest management

Jean-Luc Peyron
ECOFOR

A pan-European process of Mnisterial conferences on the protection of forests in Europe, currently Forest Europe, has been launched by France and Finland in Strasbourg (1990) and Helsinki (1993). From this process emerged a set of criteria and indicators of sustainable forest management. France was a pioneer in this field by publishing in 1995 indicators for the sustainable management of its metropolitan forests and repeating this exercise every five years until 2015. In the last edition of more than 300 pages, a synthesis has been included. It is structured according to eight major policy challenges and it focuses as much as possible to grasp the trends of recent decades. It is not only useful for stakeholders and decision makers as a comprehensive analysis of forestry issues and a support before reaching more detailed comments. It also increases the use efficiency of the existing information (structured comments and illustrations, reflections on the use of indicators) and suggests areas for improvement, both for the sustainable and multifunctional forest management and for its monitoring over time from consolidated, supplemented and more integrated indicators. Finally, there is here a promising field of cooperation at the science/policy interface.

A calculation system on vegetation carrying capacity based on water resources

Yu Pengtao, Pan Shuai, Wang Yanhui, Xiong Wei, Xu Lihong
Chinese Academy of Forestry

In dryland region such as the Loess Plateau of China, there are both serious water shortage and the lack of vegetation. For these regions, it’s the key to restore the forest vegetation according to vegetation carrying capacity of regional water resource. In this paper, vegetation carrying capacity of water resources (VCC) was defined as the maximum load of vegetation for a region to meet the requirements of a specific water yield production. Then, a calculation system for VCC was developed at the Jinghe River Basin located in Northwest China. This system was constructed based on Soil and Water Integrated Model (SWIM), a distributed hydrological model. In the calculation system for VCC, the hydrological effects of some scenarios of vegetation coverage were simulated and compared. The VCC was given by the system. The VCC in Jinghe River Basin was as forest coverage of 35%.

Valuation of forest ecosystem services as a means to find optimum forest management options – an example from Germany

Matthias Dieter, Matthias Bösch, Peter Elsasser, Joachim Rock, Sebastian Rüter, Holger Weimar
Thünen Institute

Timber production, carbon sequestration and recreational services are among the most relevant forest ecosystem services in Germany. They represent also the three categories provisioning, regulating and cultural services. Four different alternative scenarios have been compared against a baseline: (I) postponing the stands'final harvest age, (II) reducing the forest stock, (III) increasing the share of forest area set aside, and (IV) confining the level of harvesting.
The cost and benefit calculation has been done within a comprehensive framework that accounts for both, value added impacts on downstream industries and impacts on the values of non-market goods and services of forests. Carbon storage in the harvested wood products (HWP) pool is also accounted for. In an overall socio-economic perspective, the results show that none of the alternative forest management scenarios outperforms the baseline scenario, which is modeled rather close to the actual forest management planning. Only at the end of the 40 years period postponing the final harvest age (scenario I) turns out to be more beneficial as does reducing the forests stock (scenario II) at the beginning. Variation of the chosen carbon price as the most uncertain input variable does not change this finding.

Multi-functional forests promote catchment resilience and the provision of watershed services

Ashley Webb[1], Wang Yanhui[2]
1. NSW Department of Primary Industries, Tamworth Agricultural Institute
2. Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

Empirical evidence indicates that the best quality drinking water is derived from catchments that are predominantly forested. Furthermore, data from the USA demonstrates that there is an inverse relationship between the proportion of a catchment that is forested and the cost of treatment required to meet drinking water standards. Logically, from an economic, public health and environmental perspective, it is prudent to maintain or improve forest cover in drinking water catchments. Based on our research in both the northern and southern hemispheres, however, there has been a strong trend in the past century to manage water supply catchments by excluding any form of disturbance, such as timber harvesting or wildfires. This has led to the development of large tracts of single aged forests, often of one or few species. While such forests may be perceived as beneficial to water supplies by treatment authorities, it exposes forests to large scale disturbances, such as extreme wildfires, hurricanes, or insect attack, with potentially catastrophic implications for soil erosion, sediment and habitat loss and detrimental water quality. We argue, based on case studies from around the world, that with increasing climate variability and increased frequency of catastrophic events, greater catchment resilience can be achieved by the promotion of multi-aged, multi-species, multi-functional forests to ensure the provision of watershed services into the future.

Simulating effects of silvicultural interventions on selected forest goods and services - a case study in subtropical China

Wu Shuirong
Chinese Academy of Forestry

Silvicultural interventions alter forest characteristics such as stand structure, tree species composition and developmental stage, which in turn influence the quality and quantity of goods and services a forest provides, such as wood production, carbon and biodiversity. In this paper, a forest growth simulator PICUS and cost-benefit analysis are applied to assess the effects of five silvicultural strategies of two selected species Pinus massoniana and Castanopsis hystrix on economic and ecological benefits in subtropical China. The results of the study can be used to show to what extent tree species selection and management activities affect forest goods and services. A proposal of using such tools more often in forest planning processes to support the development of forest land use visions and policies is also presented.

Target tree management based on GIS

Pang Lifeng
Chinese Academy of Forestry

This paper analyzes the differences between the management objects of the natural forest management and the traditional forest management, and points out the necessity of the fine management of the target tree. First the connotation of the target tree were analysised; then management content of target tree in the life cycle were Sorted out; Lastly the article took target tree survey data and forest resource data as study objects in Southern Subtropical China.Target management system was constructed based on GIS and achieved the corresponding functions using ArcEngine technology, spatial database technology and C# ;This study provides technical support for the management of the target tree in the near natural forest.

Application of simulated annealing algorithm in three increasing difficult forest planning problems

Dong Lingbo[1], Pete Bettinger[2], Liu Zhaogang[1],Qin Huiyan[1]
1. Northeast Forestry University
2. University of Georgia

[Objective] Harvest adjacency and green-up constraints have become the most commonly used constraint types for forest spatial harvest scheduling in the developed forestry countries across the worldwide during the last decades, however few published papers have focused on this issue in our country. Therefore, the concept of this forest management technique will be introduced detailed with some examples from the part of northeastern China and four hypothetical forest datasets with different age class distributions (i.e., young, normal, older and spatially organized), which can provide some insights for the sustainable management of forest ecosystem in our country. [Method] The actual forest dataset (i.e., Pangu forest farm) used in this paper covered a

123423 ha forest land which was divided into 6421 management units, and the four hypothetical forest datasets represented a 900 ha Larix gmelinii plantation forest land that consist of 30 row×30 column 1-ha grid land. Using simulated annealing algorithm as an optimization technique, three increasing difficult forest planning problems were estimated for the five forest landscape, which were used for analyzing the effects of different spatial constraint types on the results of forest planning. The objective functions for the three planning problems were all to maximize the discount net present value for timber production of forest ecosystem. The first problem, non-spatial problem, does not include any type of spatial information. However, the second and third problems, i.e., the unit restriction model (URM) and area restriction model (ARM) problem, are all estimated on the basis of non-spatial problem. URM problem prohibits strictly the neighboring management units to be scheduled for a final harvest during the same time period, however the ARM allows some limited neighboring units to be scheduled for a final harvest during in the same time period as long as the total final harvest area less than a user defined maximum size. Therefore, all the decision variables related to management units are binary (0, 1), and the management activities we considered are clearcut (final) harvest or no harvest. In addition, the three planning problems all subject to the even-flow harvest constraint, green-up constraint, minimum harvest age constraint and the number of harvest constraint for each unit (or stand). [Result] The results showed that the coefficient of variation of the objective function values for each planning problem with actual forest dataset only ranged from 0.10% to 3.51%, indicating the perfect stability of simulated annealing algorithm. The objective function values for the URM and ARM problems reduced 11.78% and 0.33% respectively when compared that with the non-spatial problem, however the temporal and spatial outputs of forest management treatment across a landscape have become more reasonable. The percentage of harvest areas across the planning horizon of the optimal forest management plan for each planning period were all relative less, which only accounted for approximately 0.44% of the total area of the forest dataset. The similar results were obtained for the four hypothetical forest datasets. These results were logically perfect in line with the criterions of forest sustainable management. [Conclusion] Spatial constraints of forest management treatments not only increased the complexity of forest planning model, but also significantly decreased the economic benefits of timber production from forest ecosystem, however the outputs of forest management plans might be more suitable for the forest sustainable management.

Economical methods for conservation of tropical forests by local inhabitants

Elena Mechik
University of Hamburg

Deforestation of the tropical forests is one of the main factors affecting climate change and biodiversity loss. One of the methods to protect the rain forests from logging is by encouraging the inhabitants of tropical forests' to use the forest in a sustainable way by collecting and trading with Non Timber Forest Products (NTFP), such as nuts, fruits, roots, etc. By stimulating an increase in income of harvesters through processing and sale of added value products, not only a raise of the living standards of the community will occur, but it will also make the processing and adding value to the NTFP economically attractive.

This paper shows the experience and introduces an economic instrument, which can be used to protect tropical forests with active forest management by local population. It represents research results about the conditions of Brazilian Amazon rainforest protection and the attitude of local inhabitants towards this topic. The economic ways and methods of getting local people higher profits from the sale of NTFP, and opportunities for encouraging local communities to protect tropical forests were analyzed. A scheme of a processing center for NTFP has been proposed with possibilities for its financing. Proposals regarding juridical solving of challenges for protection of tropical forests were made. Our research allowed identifying major communities' challenges affecting the protection of tropical forests which include social, environmental, legal, economical, demographic, and political issues. We proposed a possible program to increase the communities' income, performed market research and proposed an economic implementation model. Our research showed that the solution to these challenges is only possible in combination with economical and political methods.

The combination of flow cytometry and marker-aided selection: a new way to screen the ploidy level of willows

Guo Wei , Dai Xiaogang , Chen Yingnan , Yin Tongming
Nanjing Forestry University

Flow cytometry (FCM) and marker-aided selection were introduced to estimate the nuclear DNA content and ploidy level of Salix. Totally fifty-five individuals, belonging to twenty taxa, were tested by FCM, and 2C-values ranging from 0.68pg to 1.11 pg and 1.52pg to 1.88pg were obtained for diploid and tetraploid individuals, respectively. The CV values ranged from 2.76% to 5.82% (mean 4.54%) and could be regarded as satisfactory. As for marker-aided selection, thirty-seven randomly selected willows and six primer pairs with high polymorphism were used in SSR genotyping. For willows that were estimated to be diploid by FCM, only one or two alleles were detected by all the primer pairs, whereas three or four alleles were detected in tetraploid ones by at least one primer pair. Results showed that the ploidy levels identified by FCM were consistent with that of marker-aided selection in all samples. This study established a desirable toolkit for identifying ploidy level from natural willow stands.

Spatial patterns and storage composition for woody debris in a natural secondary forest dominated by Pinus tabulaeformis on Loess Plateau, P. R. China

Gu Li, Li Weizhong
Northwest A&F University

Woody debris (WD) is an important part of ecosystem, and the characteristics are expected to reflect forest features. The reservoir, spatial patterns and interspecific associations of WD were examined within the natural secondary forest, which was mature relative to other forest types on Loess Plateau in northwestern of China. Data were collected in a 1 hm2 (100 m ?100 m) sample plot which had been established In August 2014. The species of Pinus tabulaeformis is the dominant tree species in this forest, countering for >51% of the total number of living trees, and the total WD biomass was 10.73 t·m-2, which displayed a large variation in WD type, diameter class and decay class. Ripley's K functions from the spatial-point-pattern-analysis method were used to analyze the spatial distribution and interspecific associations among main species, and the coexistence mechanism among such species was interpreted, by extension, to forecast their future. The spatial pattern of WD was closely related to spatial scale, which exhibited a clumped pattern on small scale, while exhibited a random pattern on large scale. The natural secondary forest of Pinus tabulaeformis have experienced a long period of low human interference, which indicated that interspecies competition played a crucial role in distribution pattern of WD. The dominated Pinus tabulaeformis species showed a negative association with Betula platyphylla and Populus davidiana species on small scale but a positive association with them on large scale, thus the community was fairly stable. The spatial pattern and interspecies relations of WD were the results of long-term interaction between the natural secondary forest community and surrounding natural environment. The findings provided a scientific basis for the sustainable management and protection of natural secondary forest ecosystems on Loess Plateau.

Forests, people and climate change: an empirical study in the drought prone area of South West Bengal, India

Jyotish Basu
West Bengal State University, Barasat, Kolkata

In an era of global climate change forests have key role in the mitigation of climate change through carbon storage and adaptation through livelihood improvement of forest-dependent people. Forest constitutes an integral part of social life of tribal people and contributes substantially to the source of food supply and livelihood security of 300 million rural people. The government of India has adopted Joint Forest Management (JFM) in 1990 and under JFM about 118213 forest protection communities and more than one crore families are involved in the management of forests. More than 22 million hectares of degraded land are managed under JFM. There are two objectives of the study. First, how Joint forest management (JFM) helped to enhance forest cover, afforestation and regeneration of forest and increase in carbon stock of forest land, reduce illicit felling of trees, reduce area under illegal encroachments, forest fire prevention and control. Second is to identify household's adaptation options and to estimate the factors responsible for the decisions of adaptation to climate change using the probabilistic model of Heckman's two-step process. This paper is an empirical study based on data collected through field survey. This study covers two villages in drought prone district of West Bengal with 120 households in 2012. The results of the study revealed that the carbon sequestration rates in regenerating forests under joint forest management systems has increased, reduced the forest fire through the community involvement and illicit felling of trees has declined in JFM areas. The paper has identified the household's adaptation options such as migration, formation of Self-help Group (SHGs), accessibility of non-timber forest products and animal husbandry. Both socio-economic and climatic factors play a role in this decision-making process. The paper has important policy implications for poverty reduction, livelihood generation, sustainable forest management and climate strategy

A novel thinning approach for biodiversity improvement and soil protection in artificial pinewoods of Italy

Maurizio Marchi[1], Elisa Bianchetto[1], Isabella De meo[1], Silvia Landi[1], Stefano Mocali[1], Elena Salerni[2], Paolo Cantiani[1]
1. Consiglio per la ricerca in agricoltura el'analisi dell'economia agraria (CREA),
2. University of Siena

The Mediterranean area is a well know basin for biodiversity and many endemic forest species are there located as a result of glacial refugia. Many provenances will probably be helpful in future for northern countries to enrich the gene pool to cope with increasing temperatures and lower amounts of precipitations. Among the Mediterranean countries, the Italian peninsula is an important hotspot due to its morphological conformation and geographical position. However many simplified artificial stands were created in the early XX century. Very low genetic diversity and structural homogeneity make these systems extremely sensitive to water stresses, wind storms and heat strokes. Artificial Black pine forests (Pinus nigra Arnold) in Italy occurs mostly in pure stands of even-aged forests (50 years old on average) and are among the most simplified forest systems. According to the last National Forest Inventory (INFC 2005) this category covers an area of 236,467 hectares, corresponding to 2.5% of the total national forested area. Many of those plantations were established between the 1920 and 1960 for economic and social purposes on bare or abandoned and overexploited lands in mountainous regions to prevent soil erosion. Management plans were always developed but rarely applied and, as a result, many plantations were abandoned. The forest management deeply influences the natural cycle of forests. Modelling the amount and the spatial distribution of solar radiation on the ground improve the mineralization of carbon and nutrients can be controlled. The result is a greater micro-climatic variability, reflected by a higher number of biodiversity on soil (fungi and bacteria) and understory (animals). At the same time, silvicultural treatments as thinning in even-aged forests reduce the competition between trees, favouring well shaped dominant ones. In this view, this issue represents a focal point for future development of many forested zones in Italy. Despite many research groups focused on the most adequate thinning design and gap size, adding knowledge about the ecological influence and the economic value of thinning, the classic approach (thinning from below) is still the most applied. However the impact of these treatments on the stands' structures is very low, especially concerning the carbon cycle, soil biodiversity and ecological developments. In addition, the economical sustainability is rarely achieved.

The experimentation has been carried out into two research areas in Tuscany: the Monte Amiata and the Pratomagno. In both cases 9 hectares were delimited and three circular plots were randomly located in each. Before harvesting, all trees were fully measured in each plot collecting the diameter at breast height (dbh), total height of the tree, crown depth, height of maximum crown width, rank and crown projection. All trees were numbered and geo referenced using the Filed Map technology. Two different treatments on 2/3 of the total area were applied. Three hectares were harvested following the classical thinning from below approach and 3 using the selective thinning method. The remaining 3 hectares were kept as control area (no treatment). Trees were marked according to the thinning criteria and removed in the late Summer of 2015. Collected data demonstrated the superiority of the selective thinning in achieving the ecological criteria of enriching soil biodiversity compared to the classical approach. Even if more trees were removed with the classical approach this difference was not significant (345 tr.ha-1 v.s. 336 tr.ha-1). On the opposite, the average dimensions of cut trees was relevant and statistically significant. A greater volume was harvested in both areas with the selective thinning. Bigger trees in terms of dbh and total height were removed, corresponding to a higher economic value of the harvesting. In addition, the spatial distribution of gaps and stability of isolated trees enforced the effect of the selective approach on stand stability. A wider amount of crown area was removed with the selective thinning and concentrated in few zones, in line with the basics rules of silviculture when the aim is to increase biodiversity. The impact of the selective thinning on the crown structure was focused on the codominant layer and the proportion of removed crown area was concentrated around the target trees. Only stable trees (slenderness ratio above critical threshold) were isolated avoiding lack of mechanical stability at the border of gaps. These trees represent also the future trees to be removed at the end of the silvicultural cycle. In this view, also the production (economic value) of these artificial plantations was highly improved. Thanks to the LIFE+ SelPiBio project (www.selpibio.eu), further results will be added in future concerning improvement of soil biodiversity.

Session CSF-06 (88-4): Role of genetics and physiology in forestry sustainable management

The diversity of symbiosis mycorrhizal fungi of terrestrial orchids in Yunnan, China

Ma Huancheng
Southwest Forestry University

Yunnan province is located in the southwestern China bordered with Myanmar, Laos and Vietnam. Yunnan is the province with richest biodiversity of orchids in the country. It has proximately 1000 orchid species in the area of 390,000 km2, while whole country only has proximately 1500 orchids species in the area of 9.6 million km2. Some places like Xishuangbanna grows almost 500 species within the area of 20,000 km2. Our experiments were aimed to understand the linkage of the abundance of mycorrhizal fungi (MF) to the biodiversity of orchid species in Yunnan province, China. The roots anatomy observations were carried out under both optical microscope and electronic microscope. The results shown that symbiosis were formed with evident of hypha and pelotons in the roots of many species under genus Cymbidium and Cypripedium. To test the abundance of MF of orchids, 89 orchid sample plants belonging to 11 orchid sepcies were collected from 8 prefectures in Yunnan. The roots of orchids were rinsed with running water and sterile with 75% alcohol and 0.1% mercury bichloride solution. Totally 184 strains of MF were isolated. Among them, 65 strains had higher infection rate. They belong to the genera of Orchidaceous Rhizotonias, Rhizoctonia, Chaetomium, Trichoderma, Fusarium. Other strains with relatively low infection rate were belong to the genera of Diplococcoium, Acremonium, Sarcinella, Papulaspora, Trichosporiella, Microascu, Hyphomycetes, Gliomastix murorum, Mycena, Cafenularia etc. The germination of orchid seed inoculated with selected MF and co-culture of seedlings with MF shown a positive result. The germination ratio or growth ratio is higher under MF inoculation than those of control. By inoculating the selected MF strains onto the soil planted with Cymbidium goeringii, it was found that some strains enhanced the plant growth, some did not. We assume this is because the existence of the strain specific and trait specific “Orchid—MF symbiosis”. To understand the relationship between plant diversity and microbial diversity, Biolog with ECO microplate technique was used to test the carbon resource diversity under 6 vegetation types with different elevation gradients from altitude 800 to 3000 meters above sea level in the Goligong mountain in the western Yunnan. It was found that the activity of soil microbial community metabolism was decreased with the increase of elevation, while the soil microbial community richness index(H) and evenness index(E) increased with increase of election up to the altitude of 2500 meters above sea level under the vegetation of moist evergreen broad-leaved forest. To understand the function of MF to the orchids nutrition, three types of 15N-labelled nitrogen solutions, KNO3 (99.3% 15N enrichment), (NH4)2SO4 (99.5% 15N enrichment) and glycine (98.4% 15N enrichment),were injected into the the soils of mycorrhizal and non-mycorrhizal, at different depths (2.5 cm and 7.5 cm respectively), planted with C. goeringii seedlings. Total N and15N/14N was measured by continuous-flow gas isotope ratio mass spectrometry. The results suggestion that different strains of MF enhance the nitrogen absorption with different forms and at different soil depths. Generally, MF hyphae in the upper soil layer might be responsible for NH4 uptake whereas hyphae in the deeper soil layer might be responsible for organic N uptake.

Endocytic mechanisms of membrane proteins in plants--a single-molecule perspective

Li Xiaojuan, Li Ruil , Lin Jinxing
College of Biological Sciences, Beijing Forestry University
Institute of Botany, Chinese Academy of Sciences

The plasma membrane (PM) is highly dynamic and PM proteins play important roles in regulating various transport processes. Measuring the mobility and interactions of proteins is key to understanding cellular signaling mechanisms. However, bulk approaches have been unable to unambiguously monitor the behaviors of the individual PM molecules without disrupting their membrane environment. Besides, transient molecular interactions cannot be identified by conventional fluorescence imaging-approaches. In the past few years, we have developed variable-angle total internal reflection fluorescence microscopy (VA-TIRFM) to image PM proteins in intact plant cells, applied single-particle techniques to protein tracking and subunit counting, provided new information on the spatiotemporal dynamics of specific molecules and their interactions.

Endocytosis is an essential way for entry of membrane proteins, lipids, and extracellular molecules into the cell. Clathrin-mediated endocytosis plays an essential role in many cellular and developmentalprocesses. Based on single-molecule and genetic approaches, we demonstrated that Arabidopsis AP2 σ is closely associated and physically interacts with the clathrin light chain (CLC), and AP2 σ-mCherry fluorescence appears and disappears before CLC-EGFP fluorescence. In addition, the density and turnover rate of the CLC-EGFP spots are significantly reducedin the ap2σ mutant. These findings led us to conclude that AP2 is involved in the CCV initiation, assembly and maturation stages, which is required for clathrin-mediated endocytosis.
In recent years, the structure, composition, and possible functions of plant plasma membrane raft-like domains have been described. Similar to animal cells, plant cells have additional endocytic pathways besides clathrin-mediated endocytosis. In our investigations, we found that Arabidopsis flotillin1 (AtFlot1) was associated with the membrane microdomains, and participated in clathrin-independent endocytosis. By using VA-TIRFM, we demonstrated that the dynamic behavior of GFP-Flot1 puncta was different from that of CLC-mOrange puncta. Analysis of amiRNA AtFlot1 transgenic Arabidopsis plant lines established that a reduction in AtFlot1 transcript levels gave rise to a reduction in shoot and root meristem size and a retardation in seedling growth. Colocalization analysis and immunogold labeling revealed that AtFlot1 was not colocalized with CLC. These findings suggested that AtFlot1 is involved in a clathrin-independent endocytic pathway and functions in seedling development.

Further studies based on single-molecule approaches and other methods revealed that clathrin and AtFlot1-associated membrane microdomains cooperatively regulate membrane protein dynamics and endocytosis, such as PIP2;1 (plasma membraneintrinsic protein), AMT1;3 (ammonium transporter), RbohD (respiratory burst oxidase homolog D), and BRI1 (brassinosteroid receptor) and the membrane microdomain played a role in altering its activity of these proteins by positively or negatively affecting their clustering and signal transduction.

Enzyme protein complex for monolignol biosynthesis

Li Quanzi [12]
1. State Key Laboratory of Tree Genetics and Breeding, Research Institute of Forestry, Chinese Academy of Forestry;
2. Key Laboratory of Tree Breeding and Cultivation, State Forestry Administration

Lignin is a major component in the secondary cell walls of vascular plants, accounting for more than 20% of cell wall components in wood. However, it negatively affects the cellulose digestibility and is considered as a major barrier for lignocellulose-based biofuel production. Characterization of the enzymes involved in monolignol biosynthesis has facilitated the reduction of lignin content and alteration of lignin composition. However, the understanding on the regulation of lignin biosynthesis is still limited. Recently protein-protein interaction has been found to affect the regulation of lignin biosynthetic pathway. In P. trichocarpa, cinnamic acid 4-hydroxylases (C4H1 and C4H2) and p-coumaroyl ester 3-hydroxylase (C3H3) form a protein complex, catalyzing 3-hydroxylation of 4-coumaric acid. Two 4-coumaric acid:CoA ligae (4CL) isoforms, 4CL3 and 4CL5, can affect the direction and rate of metabolic flux for monolignol biosynthesis by forming protein complex. Here we discovered that two monolignol biosynthetic pathway enzymes, cinnamyl alcohol dehydrogenase (CAD) and cinnamoyl CoA reductase (CCR), interact in vivo and in vitro to form a heterodimer by BiFC and co-immunoprecipitation. Decreasing each protein content of these two enzymes by RNAi caused an activity reduction of the other enzyme in the xylem. These results indicate the heterodimer of CAD and CCR may have a regulatory role in *P. trichocarpa*.

A competition model for dissecting tree growth

Wu Rongling
Pennsylvania State University, USA
Beijing Forestry University, China

Tree growth is a complex biological process, regulated by the interactions of genes and environment. The identification of external and internal factors that contribute to stemwood growth has been one of the most important tasks in modern biology and tree breeding programs. Here, we present a new theory that dissects growth into its interactive components based on ecological and evolutionary principles. By integrating this theory with game theory, we derive a series of statistical procedures that can characterize a complete set of genetic control mechanisms underlying stemwood growth. These procedure can not only estimate the direct effects of genes from one individual on its own phenotype, but also capture the indirect effects of genes from one individual on the phenotypes of its partners that compete for the same resource with it, as well as chart the network of epistatic interactions between genes from different individuals. We implement a set of ordinary differential equations to quantify the pattern of ecological interactions between co-existing individuals and identify specific genes or quantitative trait loci that affect these ecological interactions. The new theory rules out the relative roles of competition and cooperation in tree growth.

Transcription networks of genes regulated epigenetically in response to drought stress in *Populus trichocarpa*

Li Wei [1], Lin Ying-Chung [1,2],Li Shuang [1], Zhou Chenguang [1],Da Xiufang i[1],Wang Pengyu [1], Chen Su [1], Shi Rui [1,2], Sermsawat Tunlaya-Anukit[1,2], Jack Wang[1,2], Vincent Chiang[1,2]
1. State Key Laboratory of Tree Genetics and Breeding, Northeast Forestry University
2. Forest Biotechnology Group, Department of Forestry and Environmental Resources, North Carolina State University

Plant growth and forest productivity are severely affected by adverse environmental conditions such as drought stress. Plants respond and adapt to drought stress through coordinated changes at transcriptional level of gene networks. This requires complex transcriptional regulation and a change in chromatin accessibility. However, the molecular connections among these factors and with drought response are not known. Here, we report on the genome-wide distribution pattern of histone H3 lysine 9 acetylation (H3K9ac) and the pattern's association with whole genome expression profiles using a combination of chromatin immunoprecipitation and RNA sequencing (ChIP- and RNA-seq) methods in Populus trichocarpa subjected to soil-water depletion. Integrative analysis of ChIP- and RNA-seq results reveals that H3K9ac affects transcription of a number of genes involved in drought stress tolerance. Furthermore, we observed an enrichment of abscisic acid–responsive elements (ABREs) in promoter regions of a set of genes whose transcription levels are significantly associated with H3K9ac modifications in their promoters. To verify our hypothesis that H3K9ac regulates drought stress-responsive genes through the recruitment of histone modifiers to their promoters by corresponding transcription factors (TFs), we examined the interplay between the drought-inducible histone acetyltransferase ADA2-GCN5 complexes and ABRE binding protein 1 (AREB1) TFs and their action on one of the putative target genes, PtrNAC7, which is the ortholog of ANAC002/ATAF1 that negatively regulates drought stress-responsive signaling. Our results indicate that the ADA2-GCN5 complexes interact with the PtrAREB1s, which directly bind to the ABRE motifs in the promoter of PtrNAC7. The PtrAREB1s can recruit the ADA2-GCN5 complexes in the promoter of their common target, PtrNAC7, triggering its transcription activation. We propose that crosstalk between H3K9ac and TFs is important for gene expression reprogramming in plant response to drought and provide a basis for understanding the role of epigenetic modifications in regulating this phenomenon.

Researches on non-wood forest plants in the Republic of Korea – Based on the articles published in the Journal of Korean Forest Society from 1962 to 2013

Jae-Seon Yi[1], Hyun-Seok Lee[2], Chan-Hoon An[2], Eun Ju Cheong[1], Jun-Won Kang[2], Jeong-Ho Song[2], and Mahn-Jo Kim[2]

1. College of Forest and Environmental Sciences, Kangwon National University, Chuncheon, Republic of Korea

2. National Institute of Forest Science, Seoul, Republic of Korea

The articles, published in the Journal of Korean Forest Society from Volume 1 (1962) to Volume 102 (2013), were investigated for the research trend analysis about forest plants for special purposes, i.e., edible plants, medicinal plants, feed resources, landscape plants, fiber plants, industrial usage, bee plants, bioenergy/ phytoremediation uses, dye materials, and rare/endangered/endemic plants. These articles were classified again based on the contents of research into the following categories - habitat environment, ecology, physiology, propagation, silviculture (including planting and tending), genetics and breeding, identification,pest and disease control, animal-related research, components analysis and extracts, vegetation survey, biotechnology, management, recreation and forest healing, and research review. Among the total 2,433 articles published, 611 (25.1%) were related to plants for special usage or purposes. The highest frequency (14.9%) in publications was found in the field of silviculture followed by physiology, propagation, identification, and genetics and breeding, in order. On the base of usage, edible plants showed higher frequency (26.5%) than others, followed by industrial purpose, bioenergy/phytoremediation usage, landscape plants, medicinal plants, and rare/endangered/endemic plants, in order. Populus was the most popular in research, showing 62 articles; and Castanea crenata 36; Pinus koraiensis 35; Robinia pseudoacacia 20; Ginko biloba 17; etc. Based on the survey and analysis, the followings are suggested: 1) improved evaluation of forest plants as non-wood resources, 2) expanding research topics on the basis of production, management, and utilization of non-wood forest resources, 3) management of database of forest

plant information and encouragement needed to strengthen cooperative researches satisfying the needs of other industrial and scientific areas, and 4) support of research on traditional knowledge.

Biomass and carbon storage genetic variation analysis of larch families and provenances

Zhang Hanguo , Li Zhixin ,Zhang Lei ,Yang Chuanping
State Key Laboratory of Tree Genetics and Breeding (Northeast Forestry University), Harbin, China

Based on the 11 provenances of 31-year Changbai larch (Larix olgensis) and 16 families of 32-year hybrid larch as research materials, high-carbon storage families and provenances of have been screened out through measuring indexes of biomass and carbon storage. By SPSS, DPS software analysis, the results showed that: (1) the Baidaoshan and Jixi provenances of L. olgensis in four test sites all grow very well and has good stability and high yielding. The total biomass and carbon storage of Baidaoshan provenance in MaoerShan, Cuohai and Jiagedaqi are ranked among the top three, with carbon storage exceeds total average by 11.11%. (2) In Qingshan, the biomass, carbon storage and timber characteristics heritability of 16 hybrid families are measured relatively higher while the carbon content rate is lower; the heritability of total biomass, total carbon family are 0.579, 0.581 respectively. Under 20% selection rate, genetic gain of the total biomass and total carbon storage are 27.29% and 29.91% respectively. According to the genetic variation and correlation, three good-growth and highly carbon sequestration hybrid larch families arefinally screen out , the carbon-storage of these three top families are 14.13% more than the average.

Complete chloroplast genome sequence of a major economic species, Ziziphus jujuba (Rhamnaceae)

Ma Qiuyue
Academy of Forestry

Ziziphus jujuba is an important woody plant with high economic and medicinal value. Here, we characterized and analyzed the complete chloroplast (cp) genome of *Z. jujuba*. Sequence analysis showed that this cp genome is 1,61,466 bp long and has a typical quadripartite structure of large (LSC, 89,120bp) and small (SSC, 19,348 bp) single-copy regions separated by a pair of inverted repeats (IRs, 26,499bp). The sequence contained 112 unique genes, including 78 protein-coding genes, 30 transfer RNAs, and four ribosomal RNAs. The genome structure, gene order, GC content, and codon usage are similar to other typical angiosperm cp genomes. The homopolymer regions in the cp genome of Z. jujuba were verified and manually corrected by Sanger sequencing. One third of mononucleotide repeats were found to be erroneously sequenced by the 454 pyrosequencing, which resulted in sequences of 1-4 bases shorter than that by the Sanger sequencing. A phylogenetic analysis based on 64 protein-coding genes showed that *Z. jujuba* was closely related to members of the Elaeagnaceae family, which will be helpful for phylogenetic studies of other Rosales species. The complete cp genome sequence of *Z. jujuba* will facilitate population, phylogenetic, and cp genetic engineering studies of this economic plant.

Fine Mapping the sex determination gene in Salix Suchowensis by SSR markers

Di Min , Dai Xiaogang , Yin Tongming
Nanjing Forestry University

Salix suchowensis is a dioecious woody plant in Salicaceae and attracts more attention in recent genetic research. Sex was treated as a morphological marker and had been mapped in a genetic linkage map established by AFLP (Amplification fragment length polymorphism) markers in previous linkage analysis. In this study, the *Salix suchowensis* fine mapping pedigree consisted of 1032 F1 backcross individuals and SSR (Simple Sequence Repeats) markers were applied to enhance the density of the genetic linkage map. On the basis of the primers polymorphic screening results, there were 24 primer pairs selected respectively from 73 primer pairs for selective amplification, and then the marker w-292-17 was discovered to be linked to the gender-deciding gene marker with a genetic distance of 0cM. This polymorphic marker was revealed the same genetic distance in an F1 population of 940 individuals. The results indicated that this locus was sex determination gene. This work provides valuable information and sequence resources for the deciphering of the sex chromosomes in *Salix suchowensis* and lays the foundation of Marker Assisted Selection (MAS) of breeding, sex gene Map-based clone and future genetic evolutionary mechanism analysis for gender chromosomes in *Salicacea*.

Variation analyses of growth and wood properties of Larix olgensis clones in China

Yin Shaopeng ,Liang Deyang ,Zhao Xiyang ,Qu Guanzheng
State Key Laboratory of Tree Genetics and Breeding, Northeast Forestry University

Take 208 Larix olgensis clones in 26-year-old as material, growth (tree height, diameter at breast height and stem straightness degree) and wood properties (wood density, fiber length, fiber width, ash content, lignin content, cellulose content, hemicellulose content and holocellulose content) were measured and analyzed. ANOVA analysis showed that except wood density and ash content, there existed significant difference in all other traits ($P < 0.01$). Phenotypic coefficient of variation and repeatability of all the traits was varied from 9.34% to 35.33% and 0.218 to 0.930, respectively. There existed significant positive correlation between tree height and diameter at breast height, but the correlation coefficients among growth characteristics and wood properties were not significant mostly. Using tree height, diameter at breast height and stem straightness degree as the index to carry out the comprehensive evaluation, 10 excellent clones (L70, L56, L82, L90, L59, L91, L61, L92, L86 and L64) were selected under the selection rate of 5%. The genetic gains of tree height, diameter at breast height and stem straightness degree of selected clones were 28.69 %, 17.96 % and 0.67 %, respectively. In addition, taking wood properties as evaluation index, with the selection rate of 5%, 10 clones (L88, L305, L59, L66, L253, L304, L277, L298, L248 and L293) were selected as excellent clones. The genetic gains of wood density, fiber length, fiber width, cellulose content and hemicellulose content of selected clones were 4.14 %, 3.64 %, 9.28 %, 6.77 % and 9.61 %, respectively. The study provided a theoretical basis for excellent *Larix olgensis* clones selection.

Transcriptome difference analysis in *Populus deltoides* with different growth potential

Ding Changjun [1],Zhang Weixi [1],Gao Ming [2], Huang Qinjun [1], Chu Yanguang [1],Su Xiaohua[1]
1. State Key Laboratory of Tree Genetics and Breeding, Research Institute of Forestry, Chinese Academy of Forestry; Key Laboratory of Tree Breeding and Cultivation, State Forestry Administration

2. Research Institute of Subtropical Forestry, Chinese Academy of Forestry

The study of the gene expression profile of Populus deltoides F1 hybrids helps to reveal the mechanism of hybrid vigor from the gene expression level. We sequenced the transcriptomes of three super-parent hybrids F1 (H1, H2, H3) , two low-parent hybrids (L1, L2), and their parents (Q1, Q2) using high throughput sequencing. We totally obtained 171 154 127 reads, with average length of 200 bp and a total of 31.32 Gb size. After filtering, we align the clean reads to the reference genome of Populus trichocarpa and 61.89% of the clean reads could be align to the reference genome. The comparison between super-parent hybrids F1 and parents (H Vs Q) revealed that 342 genes were differently expressed (87 up-regulated and 255 down-regulated). We termed the different expressed gene as DEG thereafter. Meanwhile, 577 DEGs (146 up-regulated and 431 down-regulated) were identified by comparing low-parent hybrids F1 with parents (L Vs Q), and 486 DEGs (200 up-regulated and 286 down-regulated) were identified by comparison of low-parent hybrids F1 and super-parent hybrid F1 (H Vs L). As results, 383genes that were highly related to the hybrid vigor were identified, of which 4 genes down-regulated expressed both in H Vs Q and L Vs Q, but not in L Vs Q, 72 genes down-regulated expressed both in H Vs Q and L Vs Q, 129 genes differentially expressed (19 up-regulated and 110 down-regulated) both in H Vs Q and H Vs L, 177genes differentially expressed both in L Vs Q and H Vs L. The functional analysis and pathway analysis demonstrated that there were 167, 233 and 288 DGEs could be categorized into 46, 45 and 51 functional groups, respectively. In the three main categories (cellular component, molecular function, and biological process) of the GO classification, the DEGs were mainly enriched in “catalytic activity”, “amine metabolic process” and “oxidoreductase activity” etc. These activities were reported to be involved in the carbohydrate metabolism, amino acid metabolism, energy metabolism and degradation pathways and foreign substances metabolic pathways. Heterosis, likely due to significant different expression of related genes, regulates metabolic activity closely linked to growth, e.g. photosynthesis, metabolism and absorption, and thus contributes to the formation of growth advantage.

PoplarGene: poplar gene network and resource for mining functional information for genes from woody plants

Liu Qi ,Ding Changjun ,Chu Yanguang ,Chen Jiafei ,Zhang Weixi ,
Zhang Bingyu ,Huang Qinjun , and Su Xiaohua
State Key Laboratory of Tree Genetics and Breeding, Research Institute of Forestry, Chinese Academy of Forestry; Key Laboratory of Tree Breeding and Cultivation, State Forestry Administration, Beijing, China

Poplar is not only an important resource for the production of paper, timber and other wood-based products, but it has also emerged as an ideal model system for studying woody plants. To better understand the biological processes underlying various traits in poplar, e.g., wood development, a comprehensive functional gene interaction network is highly needed. Here, we constructed a genome-wide functional gene network for poplar (covering ~70% of the 41,335 poplar genes) and created the network web service PoplarGene, offering comprehensive functional interactions and extensive poplar gene functional annotations. PoplarGene incorporates two network-based gene prioritization algorithms, neighborhood-based prioritization and context-based prioritization, which can be used to perform gene prioritization in a complementary manner. Furthermore, the co-functional information in PoplarGene can be applied to other woody plant proteomes with high efficiency via orthology transfer. In addition to poplar gene sequences, the webserver also accepts Arabidopsis reference gene as input to guide the search for novel candidate functional genes in

PoplarGene. We believe that PoplarGene (http://bioinformatics.caf.ac.cn/PoplarGene and http://124.127.201.25/PoplarGene) will greatly benefit the research community, facilitating studies of poplar and other woody plants.

Genome-wide analysis of the fasciclin-like arabinogalactan protein gene family reveals differential expression patterns, localization, and salt stress response in p*opulus*

Zang Lina [1,2], Zheng Tangchun [1], Chu Yanguang [2], Ding Changjun [2],
Zhang Weixi [2], Huang Qinjun [2] , Su Xiaohua [2]
1. State Key Laboratory of Tree Genetics and Breeding,
Northeast Forestry University, Harbin, China
2. State Key Laboratory of Tree Genetics and Breeding, Research Institute of Forestry, Chinese Academy of Forestry; Key Laboratory of Tree Breeding and Cultivation, State Forestry Administration, Beijing, China

Fasciclin-like arabinogalactan proteins (FLAs) are a subclass of arabinogalactan proteins (AGPs) involved in plant growth, development and response to abiotic stress. Although many studies have been performed to identify molecular functions of individual family members, little information is available on genome-wide identification and characterization of *FLAs* in the genus *Populus*. Based on genome-wide analysis, we have identified 35 *Populus FLAs* which were distributed on 16 chromosomes and phylogenetically clustered into four major groups. Gene structure and motif composition were relatively conserved in each group. All the members contained N-terminal signal peptide, 23 of which included predicted glycosylphosphatidylinositol (GPI) modification sites and were anchored to plasma membranes. Subcellular localization analysis showed that PtrFLA2/20/26 were localized in cell membrane and cytoplasm of protoplasts from *Populus* stem-differentiating xylem. The Ka/Ks ratios showed that purifying selection has played a leading role in the long-term evolutionary period which greatly maintained the function of this family. The expression profiles showed that 32 *PtrFLAs* were differentially expressed in four tissues at four seasons based on publicly available microarray data. 18 *FLAs* were further verified with qRT-PCR in different tissues, which indicated that *PtrFLA1*/*2*/*3*/*7*/*11*/*12*/*20*/*21*/*22*/*24*/*26*/*30* were significantly expressed in male and female flowers, suggesting close correlations with the reproductive development. In addition, *PtrFLA1*/*9*/*10*/*11*/*17*/*21*/*23*/*24*/*26*/*28* were highly expressed in the stems and differentiating xylem, which may be involved in stem development. To determine salt response of *FLAs*, qRT-PCR was performed to analyze the expression of 18 genes under salinity stress across two time points. Results demonstrated that all the 18 *FLAs* were expressed in root tissues; especially, *PtrFLA2*/*12*/*20*/*21*/*24*/*30* were significantly induced at different time points. In summary, this study may lay the foundation for further investigating the biological functions of *FLA* genes in *Populus trichocarpa*.

Overexpression of the novel *Zygophyllum xanthoxylum* C2H2-type zinc finger gene *ZxZF* improves drought tolerance in transgenic *Arabidopsis* and poplar

Chu Yanguang [1],Zhang Weixi [1],Wu Bin [2],Huang Qinjun [1],Zhang Bingyu [1],Su Xiaohua [1]
1. State Key Laboratory of Tree Genetics and Breeding, Research Institute of Forestry, Chinese Academy of Forestry; Key Laboratory of Tree Breeding and Cultivation, State Forestry Administration, Beijing, China
2. Institute of Crop Science, Chinese Academy of Agricultural Sciences, Beijing, China

Zygophyllum xanthoxylum (Bunge) is a perennial woody succulent xerophyte that is one of the most drought-tolerant plant species identified to date. In this study, the gene encoding the novel C2H2-type zinc finger protein (ZFP) ZxZF was cloned from *Z. xanthoxylum* and expressed in both *Arabidopsis thaliana* and poplar (*Populus* × *euramericana* cl. Bofeng 1) under the control of the drought-inducible promoter *rd29A*. Overexpression in *Arabidopsis* resulted in a higher survival rate and enhanced root growth compared with wild type (WT) plants under osmotic stress conditions induced by mannitol. Overexpression in poplar under stress conditions induced by PEG6000 improved photosynthetic function as evidenced by a higher maximum photochemical activity of photosystem II (PSII) (*Fv*/*Fm*) and elevated chlorophyll content. Furthermore, leaf tissue of transgenic poplar accumulated less malondialdehyde (MDA), and both superoxide dismutase (SOD) and peroxidase (POD) activities were elevated in transgenic plants. These results suggest that ZxZF overexpression played an essential role in drought tolerance in both Arabidopsis and poplar. Incorporating overexpression of ZxZF and other A1 subgroup C2H2 zinc finger proteins in plant breeding programs may result in enhanced drought tolerance.

DNA cytosine methylation differential analysis of *Pinus elliottii* × *Pinus caribaea* var. *hondurensis* and their parents

Li Yiliang[1,2], Zhao Fencheng[1,2],Li Fuming[3],Zhong Suiying[3],Zhang Yingzhong[1,2], Wu Huishan[1,2]
1. Guangdong Provincial Key Laboratory of Bio-control for the Forest Disease and Pest , Guangdong, China
2. Guangdong Academy of Forestry, Guangzhou, Guangdong, China
3. Taishan Hongling Seed Orchard, Taishan, Guangdong, China

To figure out the difference of DNA methylation level in Pinus elliottii Englem. × Pinus caribaea var. hondurensis hybrids and their parents, we used the methylation-sensitive amplified polymorphism (MSAP) method to analyze the DNA methylation pattern. Results show that DNA total methylation level is higher in highly heterotic hybrids than their parents, while lowly heterotic hybrids have DNA total methylation level lower than their parents. which shows that some sites of high heterosis combinations methylate when coming into being heterozygote while some sites of low heterosis combinations get demethylation. 6 differentially methylated DNA sites were sequenced. According to the comparative analysis, we found that those sites are isogenous with growth hormon, acetyltransferase, ribosome RNA gene, RNA methylation gene, aquaporins gene, which play a important role in regulating and controlling the heterosis of hybrids. In conclusion, we initially speculate that the generating of heterosis of hybrids is associated with the up regulation of the F1 generation hybrid genome's DNA methylation pattern and the specific gene's methylation.

Differentially expressed profiles of genes involved in dormancy and flush of vegetative buds in *Populus tomentosa* Carr.

Lei Bingqi, Gao Kai, Liao Weihua, Chen Zhong, Ma Huandi,Yang Xiaoyu, Rao Pian, An Xinmin
Beijing Forestry University

Populus tomentosa Carr. is a wide-spread species in China and grows rapidly. Bud dormancy can help trees avoiding bad conditions and is an important adaptation for many plants, including poplar. In this study we investigated the Populus tomentosa transcriptome using RNA-sequencing methods. RNA sequence data were validated using Real-Time qPCR(RT-qPCR). After removal of low-quality reads, we obtained 67,827 unigenes for dormant vegetative buds and 66,181 for sprouting ones. There were 28,672 up-regulated genes and 52,719 down-regulated genes.

Energy metabolism and redox reaction-related macromolecules were significantly increased based on a Gene Ontology and Kyoto Encyclopedia of Genes and Genomes pathways analysis. The results of the analysis show that many signal molecules, such as sugars, ABA, ethylene and so on, are related to these two stages, some flavonoid and resistance proteins are also related to dormancy and bud flush. This study improves our understanding of the genetic architecture of the *P. tomentosa* transcriptome and provides a useful resource for future functional genomic research.

In vitro tetraploid induction from leaf explants of multiple genotypes in *Populus.*

Xu Congping
Beijing Forestry University
National Engineering Laboratory for Tree Breeding, Key Laboratory of Genetics and Breeding in Forest Trees and Ornamental Plants, Ministry of Education，Beijing Laboratory of Urban and Rural Ecological Environment, College of Biological Sciences and Technology, Beijing Forestry University, Beijing, China

A protocol for tetraploids of multiple genotypes induction from in vitro leaf explants of diploid full-sib progeny [(*P. pseudo-simonii* × *P. nigra* 'Zheyin3#') × (*P.* × *beijingensis*)] by treating the leaves with colchicine is described. Leaf explants of 10 genotype full-sib progeny were cultured on MS basal medium supplemented with 1.78 μM BA and 0.27 μM NAA for 4, 5 and 6 days. Then the leaf explant was transferred to the same liquid MS medium containing different concentrations of colchicine (50, 75, and 100μM) for 2, 3, and 4 days, respectively. Results indicated that the rate of tetraploid production was significantly positively correlated with pre-culture duration, colchicine concentration and exposure time, respectively. However, there was no significant correlation between the rate of tetraploid production and genotype. A feasible protocol for tetraploid induction of multiple genotypes was described by treating leaf explants that were pre-culturd for 5 days and then immersed in liquid MS with 75μM colchicine for 72 h. The ploidy level of plantlets was tested by flow cytometric analysis and verified by chromosome counts. Size and frequency of leaf stomata had significant differences between tetraploid and diploid plants.

Dynamic changes in the transcriptome of Populus hopeiensis in response to ABA

Ji Lexiang,Wang Jia,Liao Weihua, Ye Meixia, Chen Zhong, An Xinmin
National Engineering Laboratory for Tree Breeding, Key Laboratory of Genetics and Breeding in Forest Trees and Ornamental Plants, The Tree and Ornamental Plant Breeding and Biotechnology Laboratory, College of Biological Sciences and Biotechnology, Beijing Forestry University, Beijing, China.

Populus, is a genus of 25-35 species of trees, some of which are widely grown as a source for forestry products. Due to its compact genome, poplar has been used as a model tree species in molecular biology and genomics. *Populus hopeiensis* is very drought tolerant and is therefore an excellent choice for studying this trait in trees. The rapid development of RNA-seq technology provides an opportunity to systematically analyze this trait at a genome-wide level. Since ABA plays a major role in water-deficit response in plants, the current study used RNA-seq to conduct a time course study of the response of *P. hopeiensis*. RNA-seq was conducted on leaf samples obtained from tissue-cultured plants of *P. hopeiensis* exposed to 100 μM ABA over a 24 h period. In total, 245 million raw reads were generated using an Illumina platform and after processing 204,390 transcripts were assembled using a *de novo* assembly strategy. Approximately, 93% of

the transcripts had measurable levels of expression and 24% of the transcripts were specifically expressed in response to ABA treatment. Changes in gene expression in response to ABA were complex and involved a number of different metabolic pathways and genes with a variety of functions. Major changes in gene expression in response to ABA occurred in the initial eight hours. Collectively, 4037 transcription factors (TFs) were identified, belonging to 56 families. Six dynamic patterns of TFs expression were identified which included 366 differentially expressed TFs. This study provides a global view of the transcriptional dynamics in *P. hopeiensis* in response to ABA stimulation. Additionally, it provides an important resource for future attempts to pursue a whole genome assembly and annotation in *P. hopeiensis*. The information in this study will help to develop a better understanding of the regulation of drought tolerance at the molecular level in poplar and provide direction for future studies of osmotic-stress response in poplar.

A multi-year assessment of the foreign gene stability and environmental impact of transgenic triploid *populus tomentosa* harboring an *AhDREB* gene

Lu Nan[1], Luo Zijing[1],Zhang Yue[1],Sun Yuhan[1], Chen Shouyi[2], Zhang Wanke[2],Li Yun[1]
1. National Engineering Laboratory for Tree Breeding, Key Laboratory of Genetics and Breeding in Forest Trees and Ornamental Plants of Ministry of Education, College of Biological Sciences and Technology, Beijing Forestry University, Beijing, China
2. Institute of Genetics and Developmental Biology, Chinese Academy of Sciences, Beijing, China

Tree genetic engineering may be a potential way to improve resistance for reducing environmental susceptibility and improving yields in poplar plantations. However, the instability of genetically engineered traits and possible environmental impact reduce their usefulness and commercial value. In previous study, by agrobacterium-mediated transformation, we successfully got transgenic hybrid *Populus* ((*Populus tomentosa* × *Populus bolleana*) × *P*. *tomentosa*) carrying the *DREB1* gene from *Atriplex hortensis* and proved improve the salty resistance of recipient plant. In order to evaluate the environmental impact and the long-term gene stability of transgenic poplar in field condition, a multi-year field trial for the *AhDREB* transgenic *Populus tomentosa* was conducted in the field of Dongyin, Shan dong since 2005.

To investigate whether the foreign gene was still present in the genome of receptor plants and the transcription of foreign gene after multi-years field cultivation, we randomly analyzed field-grown transgenic *Populus* in the year 2009 and 2013. The results of PCR and tissue culture experiments showed that *AhDREB*1 was present in the transgenic trees and was still expressed in leaves, stems and roots, in addition, the explants of field-grown transgenic plants also showed advantages in salty resistance by tissue culture. Which indicated that the expression of*AhDREB* gene in transgenic poplar wasstable after at least 8 years in field condition. In an experiment comparing the salt tolerance of field-grown and in vitro cultured transgenic *Populus*, the relative electrical conductivity was measured and analyzed primarily under different concentration salt stress. Then the height and ground diameter growth, SOD activity, POD activity, MDA content, proline content and chlorophyll content were measured under 0.6%NaCl stress. The results showed that the relative electrical conductivity and MDA content of transgenic lines were significantly lower ($P < 0.05$) than control lines. Overexpression of the *AhDREB* gene can significantly increase SOD activity, POD activity and proline content in transgenic poplar lines under both normal and salty stressed conditions. In addition, chlorophyll content of transgenic lines were significantly less affected than control line. Meanwhile transgenic lines maintained higher height and ground diameter growth than CK. However, the proline content, plant height growth of in vitro cultured transgenic lines significantly higher than field-grown transgenic poplar line after multi- years. While relative electrical conductivity of the former significantly lower than the latter suggesting that in vitro culture may be a better way to maintain salt tolerance of transgenic poplar.

We also studied the transgenic versus non-transgenic trees on the rhizospheric soil microbial communities and the allelopathic activity of leaves. No significant differences were detected between transgenic lines and non-transgenic controls in the number of soil microbes present. The allelopathic activity of leaves from both transgenic and non -transgenic lines also varied with sampling time and the allelopathic activity of leaves from transgenic lines did not differ significantly from those from non-transgenic lines. These results indicate that, for the observed variables, the impact on the environment of *AhDREB* transgenic *Populus tomentosa* did not differ significantly from that of the non-transformed controls on this field trial.

The persistence of *AhDEREB* genes in decomposing transgenic poplar leaf on the soil under natural condition for five months, and our data indicate that fragments of the genetically modified DNA are not detectable in the field for more than 2 months; The PCR results also indicated no foreign gene in the genomic DNA of microorganisms in the soil near the transgenic poplars, indicating that no significant gene transfer had occurred from the transgenic poplars to the microorganisms at multi years after planting. The pollen viability and pollen fertility of transgenic and non-transgenic trees were evaluated by TTC test, pollen germination method and hybridization, respectively, the results showed that the pollen viability of transgenic and non-transgenic trees were extremely low in 2016, the receptor plant they may be sterile.

Identification of the male parent of triploid rubber trees (*Hevea brasiliensis*) and the mechanism of 2n gamete formation

Yao Pengqiang
National Engineering Laboratory for Tree Breeding,Key Laboratory of Genetics and Breeding in Forest Trees and Ornamental Plants, Ministry of Education，Beijing Laboratory of Urban and Rural Ecological Environment, College of Biological Sciences and Technology, Beijing Forestry University, Beijing, China

Eight triploids were screened among offspring of the rubber tree clone GT1 by flow cytometry and chromosome counting. These triploid rubber trees and their possible parents were studied using a simple sequence repeat marker. Twenty-seven primer pairs were screened to identify the origin of 2n gametes, and to determine these triploids’ male parents. In addition, the mechanism of 2n gamete formation was studied using band configurations and microsatellite DNA allele counting-peak ratios. The results showed that 2n gametes originated from the maternal rubber tree clone GT1, contributing the extra haploid genome present in the triploids. The male parents of all triploids were successfully identified in this study. Further, many male parents were shown to provide the pollen for the formation of triploid rubber trees, including clones RRIC103 and YuYan 277-5, and three wild species; the female parent GT1 had special features and was necessary for the formation of triploids. Most rubber tree clones can provide pollen to form triploids as long as they have fertile pollen and develop synchronously with GT1. The mechanisms of 2n macrospore formation include first-division restitution and second-division restitution, but some types of 2n macrospore gamete formation remain obscure. This study has provided valuable information for the study of rubber trees, especially in polyploid research. It has also shown that the rubber tree clone GT1 has special features that should be fully exploited.

Phylogeography of Siberian apricot (*Prunus sibirica* L.) indicates a climate related boundary in northern China

Wang Zhe[1], Zeng Yanfei[2], Zhang Zhendong[1], Sheng Songbai[1], Wu Rongling[1] and Pang Xiaoming[1]
1. National Engineering Laboratory for Tree Breeding, Key Laboratory of Genetics and Breeding in Forest Trees and Ornamental Plants, Ministry of Education, Center for Computational Biology, College of Biological Sciences and Biotechnology, Beijing Forestry University, Beijing, China
2. State Key Laboratory of Tree Genetics and Breeding, Chinese Academy of Forestry, Beijing, China

East Asia has been suggested to divided into two distinct northern and southern regions because of a climate barrier between 35ºN and 45ºN. This large band itself has rarely been particularly studied by using a molecular phylogeographic approach. In this research 22 wild and semi-wild Siberian apricot populations (Prunus sibirica L.), a temperate deciduous species and widely distributed across the mountainous areas of north and northeast China, were genotyped by using two chloroplast DNA sequence, seven microsatellite loci (cpSSR) and 31 obtained nuclear microsatellite loci (nSSR) data. Haplotype variation, genetic differentiation, and demographic history of the species were estimated. The results showed that Siberian apricot had a relatively high level of genetic diversity (HT = 0.809) for mix-sequences data. Population divergence was also high for chloroplast markers variation (GST = 0.758, NST = 0.871) indicating low levels of seed-based gene flow and significant phylogeographical structure (NST > GST, P < 0.01). Both the analysis of spatial genetic structure using SAMOVA and re-clustering using STRUCTURE revealed two main genetic groups, i.e. east group (EG) and west group (WG). The geographic distribution of the haplotypes, together with the molecular phylogenetic data suggested that the existence of multiple localized glacial refugia in north and northeast China. Yanshan Mountains was the refuge for WG and Jinzhou which had not been inferred was the glacial refugium for EG. Moreover, an isolate microrefugia near Changbai Mountains was found in EG. There was a distinct boundary between the two large groups, which were fixed for two of the most ancestral haplotypes. We suspected that climate was the major factor in formation of this boundary.

Thinking and practices for strategy on a new round genetic improvement of *Populus tomentosa* Carr

Kang Xiangyang
National Engineering Laboratory for Tree Breeding, Key Laboratory of Genetics and Breeding in Forest Trees and Ornamental Plants, Ministry of Education, Beijing Laboratory of Urban and Rural Ecological Environment, College of Biological Sciences and Technology,Beijing Forestry University, Beijing, China

In this paper, in view of the significant effects of social and economic changes on poplar demands, a new round of genetic improvement strategy for Populus tomentosa was proposed based on analyzing the current situation and problems in combination with thinking and practices on breeding improved varieties. Design appropriate breeding objectives for different cultivation area and application requirements. Especially cultivate fast-growing, high-quality, and high resistance timber forest and male greening varieties, as well as the varieties exhibiting strong resistances to cold, drought, high temperature and water. According to the climatic regionalization and genetic differentiation of the natural populations, it should not only enrich the existing gene pool in the south distribution area (Guan County, Shandong Province), but also add a new one in the north distribution area. Thus effective sub-regional preservation and utilization of P. tomentosa genetic resources would be realized. Given the problem that it is still not taking full advantage of maternal

effect in P. tomentosa breeding, screen out female parents with good fertility and general combining ability though the analysis of half-sib progenies in the gene pool, and identify the male parents for the superior individuals using molecular markers. Build parents group that are suitable to different breeding objectives though the comprehensive assessment on main traits and genetic diversity, and then develop new varieties of P. tomentosa allotriploid using the gametes chromosome doubling technique. Given the complex grafting technology, high-cost, and easy aging of the seedlings for P. tomentosa breeding, exploiting the rejuvenation of tissue culture plantlets and suckers, vessel and field hard-wood cutting will be a good way to fulfill low-cost, effective and quickly large-scale propagation for P. tomentosa.

Transcriptome profiling of Populus tomentosa in response to cold stress by deep sequencing

Yang Xiaoyu[1],Chen Zhong[1], Yang Xiong[1],Gao Kai[1],Rao Pian[1],
Lei Bingqi[1], Liu Xuezeng[2], Li Guanghua[2],An Xinmin[1,3]
1. National Engineering Laboratory for Tree Breeding, Key Laboratory of Genetics and Breeding in Forest Trees and Ornamental Plants of the Ministry of Education, College of Biological Sciences and Biotechnology, Beijing Forestry University, Beijing, China
2. Henan Longyuan Flowers&Trees Co.,Ltd, Xuchang, China
3. Beijing Forestry University Yanling Collaborative Innovation Center, Xuchang, China

Low temperature adversely affects the growth and development of plants, thereby limiting their spatial distribution, commercial quality, yield, and survivorship. Populus tomentosa is a tree species that occurs in northern China, where it has important economic and ecological benefits. To improve understanding of the molecular mechanisms underlying responses to cold stress in this poplar, we performed transcriptome analyses using Illumina/Solexa-based RNA Sequencing technology. Two cDNA libraries were constructed and sequenced, generating 41,874,406 and 46,938,396 high quality sequence reads, respectively. After de novo assembly and quantitative assessment, 126,514 unigenes were identified, among which 1256 were differentially expressed. Specifically, 730 were upregulated and 526 were downregulated in response to cold stress. We performed Gene Ontology and Kyoto Encyclopedia of Genes and Genomes enrichment analyses to identify the relevant biological functions of differentially expressed genes. We obtained a series of candidate genes that respond to cold stress and were related to the cellular membrane system, intercellular osmoprotectants, antioxidants, hormone and calcium signal transduction, and photosynthesis. Diverse transcription factors with divergent expression patterns were identified. Finally, the RNA sequence data were examined using quantitative real-time PCR. Our study provides a better understanding of plant cold tolerance and gives important background information that will aid further studies on cold response mechanisms.

Induction of unreduced megaspores in *Eucommia ulmoides* by high temperature treatment during megasporogenesis

Li Yun
National Engineering Laboratory for Tree Breeding,Key Laboratory of Genetics and Breeding in Forest Trees and Ornamental Plants, Ministry of Education, Beijing Laboratory of Urban and Rural Ecological Environment, College of Biological Sciences and Technology, Beijing Forestry University, Beijing, China

Eucommia ulmoides Oliver is an important temperate species because it contains Eucommia

rubber, iridoids, and other medicinal substances. Triploid breeding may be an effective way to improve the contents of gutta percha and other secondary metabolites in Eucommia leaves. To obtain triploid trees, 2n female gametes were induced by exposing female buds to high temperatures. Eucommia female flower megasporocytes start meiosis when adjacent male Eucommia trees, under the same cultivation conditions, begin shedding. Meiotic division of the megaspore takes about 5 days to complete. We estimated the period of megaspore mother cell meiosis based on the number of days since the male flower produced its powder. Female buds after pollination were treated with various temperatures to induce megaspore chromosome doubling. Among the offspring, 23 triploid seedlings were detected; the highest efficiency of triploid production was 5.74%. Our findings indicate that the most suitable stage of meiosis for inducing megaspore chromosome doubling is between the pachytene and diplotene, and that the megaspore should be kept at 45°C for 4 h.

A global view of transcriptome dynamics during male floral bud development in Populus tomentosa

Chen Zhong, An Xinmin
National Engineering Laboratory for Tree Breeding, Key Laboratory of Genetics and Breeding in Forest Trees and Ornamental Plants of the Ministry of Education, College of Biological Sciences and Biotechnology, Beijing Forestry University, Beijing, China

Woody perennials have a multiple-year delay in flowering, and adult trees repeats flowering annually and can also cycle between growth and dormancy. To obtain comprehensive overview of dynamic transcriptome during male floral buds development in Populus tomentosa, high-throughput RNA-seq was employed between eight stages including floral induction, floral initiation, and organ development. Among de novo assembly of 109,212 unigenes, 6,959 genes were differentially expressed (DEGs) between eight stages of floral buds. Gene Ontology (GO) enrichment identified many GO classes were overrepresented, including ‘response to environmental stimuli’ and ‘plant-type spore development’. Approximately 1/3 DEGs were transcription factors (TFs). We analyzed several genes and gene families in depth, including MADS-box TFs, Squamosa promoter binding protein-like family (SPL), receptor-like kinases (RLK), FLOWERING LOCUS T (FT)/TERMINAL-FLOWER-LIKE 1 (TFL1) family, genes involved in anther and tapetum development, and several well-known genes such as LEAFY, WUSCHEL and CONSTANS. The dynamic expression of 32 important floral genes was validated by reverse transcription quantitative PCR. Furthermore, in order to explore flowering regulatory mechanism in poplar, we selected some key floral genes in different flowering pathways and constructed weighted gene co-expression networks. Many modules of co-expressed genes and hub genes were identified, such as LEAFY and SPL. In summary, this work provide a available genomic resource for unraveling the functions of many genes involved in flower development in poplar and other woody perennials, and new tools for breeding and biotechnology.

Transcriptome analysis provides insights into wood-formation during larch tree aging

Li WanFeng [1], Yang Wenhua [1], Zhang Shougong [1],Han Suying [2],Qi Liwang [1]
1. State Key Laboratory of Tree Genetics and Breeding, Research Institute of Forestry, Chinese Academy of Forestry
2. State Key Laboratory of Tree Genetics and Breeding, Research Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

Age affects tree growth and development. However, the underlying mechanisms are poorly understood, particularly at the molecular level. Here we investigated the transcriptomic changes of the uppermost main stems of Larix kaempferi in an entire rotation period using the RNA-Seq method. In total, ~151 million reads were obtained from the stems of 1-, 2-, 5-, 10-, 25-, and 50-year-old trees. Combining these with the published sequencing reads, 299,637 assembled transcripts were generated, of which 161,232 were annotated. 12,927 transcripts were identified as differentially-expressed genes (DEGs); function enrichment analysis of these DEGs showed that gene ontology terms associated with the processes of wood-formation were enriched, such as cell differentiation, growth and death, and its hormonal regulation. Based on the expression patterns of L. kaempferi homologues of genes associated with ethylene, calcium, and cell-wall expansion and synthesis, the regulatory network of tracheid growth was outlined. Altogether, the comparative transcriptomic analysis demonstrated that the molecular aspects of aging effects on L. kaempferi wood-formation, and the identification of genes implicated in the regulatory network of tracheid growth provide a means of investigating the regulation of wood-formation in gymnosperm trees, and offers potential targets for genetic manipulation to improve the properties of xylem fibers.

The diversity of symbiosis mycorrhizal fungi of terrestrial orchids in Yunnan, China

Ma Huancheng [1,2], Wu Jianrong [2]
1. Southwest Forestry University
2. The key laboratory of State Forestry Administration for biodiversity conservation in Southwest China affiliating to Southwest Forestry University, Yunnan Province, China.

Yunnan province is located in the southwestern China bordered with Myanmar, Laos and Vietnam. Yunnan is the province with richest biodiversity of orchids in the country. It has proximately 1000 orchid species in the area of 390,000 km2, while whole country only has proximately 1500 orchids species in the area of 9.6 million km2. Some places like Xishuangbanna grows almost 500 species within the area of 20,000 km2. Our experiments were aimed to understand the linkage of the abundance of mycorrhizal fungi (MF) to the biodiversity of orchid species in Yunnan province, China. The roots anatomy observations were carried out under both optical microscope and electronic microscope. The results shown that symbiosis were formed with evident of hypha and pelotons in the roots of many species under genus Cymbidium and Cypripedium. To test the abundance of MF of orchids, 89 orchid sample plants belonging to 11 orchid sepcies were collected from 8 prefectures in Yunnan. The roots of orchids were rinsed with running water and sterile with 75% alcohol and 0.1% mercury bichloride solution. Totally 184 strains of MF were isolated. Among them, 65 strains had higher infection rate. They belong to the genera of Orchidaceous Rhizotonias, Rhizoctonia, Chaetomium, Trichoderma, Fusarium. Other strains with relatively low infection rate were belong to the genera of Diplococcoium, Acremonium, Sarcinella, Papulaspora, Trichosporiella, Microascu, Hyphomycetes, Gliomastix murorum, Mycena, Cafenularia etc. The germination of orchid seed inoculated with selected MF and co-culture of seedlings with MF shown a positive result. The germination ratio or growth ratio is higher under MF inoculation than those of control. By inoculating the selected MF strains onto the soil planted with Cymbidium goeringii, it was found that some strains enhanced the plant growth, some did not. We assume this is because the existence of the strain specific and trait specific “Orchid—MF symbiosis”. To understand the relationship between plant diversity and microbial diversity, Biolog with ECO microplate technique was used to test the carbon resource diversity under 6 vegetation types with different elevation gradients from altitude 800 to 3000 meters above sea level in the Goligong mountain in the western Yunnan. It was found that the activity of soil microbial community metabolism was decreased with the increase of elevation, while the soil microbial community richness index(H) and evenness index(E) increased with increase of election up to the altitude of 2500 meters above sea level under the vegetation of moist evergreen broad-leaved forest. To understand the function of MF to the orchids nutrition, three types of 15N-labelled nitrogen solutions , KNO3 (99.3% 15N enrichment), (NH4)2SO4 (99.5% 15N enrichment) and glycine (98.4% 15N enrichment),were injected into the the soils of mycorrhizal and non-mycorrhizal, at different depths (2.5 cm and 7.5 cm respectively), planted with C. goeringii seedlings. Total N and15N/14N was measured by continuous-flow gas isotope ratio mass spectrometry. The results suggestion that different strains of MF enhance the nitrogen absorption with different forms and at different soil depths. Generally, MF hyphae in the upper soil layer might be responsible for NH4 uptake whereas hyphae in the deeper soil layer might be responsible for organic N uptake.

Effects of overexpression of HbDAHPS on stress tolerance in Arabidopsis Thaliana

An Zewei , Cao Mingrui, Fang Jialin , Li Weiguo , Huang Huasun
Rubber Research Institute, Chinese Academy of Agricultural Sciences

Shikimate pathway is associated with plant resistance. The study of key enzymes in shikimate pathway is helpful to understand the mechanism of plant stress resistance. The main trunk of shikimate pathway consists of seven catalyzed reactions. 3-Deoxy-d-arabino-heptulosonate-7-phosphate synthetase (DAHPS) is the key enzyme which catalyzes the first reaction in shikimate pathway, playing a vital role in controlling chorismate biosynthesis. We cloned DAHPS gene from rubber tree. In order to investigate the function of HbDAHPS under abiotic stress, HbDAHPS was overexpressed in Arabidopsis thaliana. The wild type Arabidopsis (WT) and two transgenic lines (S1 and S2) were analyzed under drought, salt and cold stress, respectively. The survival rates of WT, S1 and S2 were 0, 64.3%, and 57.1% under drought for one week, respectively. All lines survived under salt stress, but the survival rates were 86.7%, 93.3%, 92.5%, respectively. Under PEG stress, only 13.3% of WT survived, and the survival rates of S1 and S2 were 93.3% and 97.5%, respectively. The growth of WT was restricted under cold stress, in contrast, S1 and S2 grew vigorously. All of the results showed that the overexpression of HbDAHPS enhanced drought, salt and cold resistance in Arabidopsis.

Dynamics of intra-annual wood formation of Pinus massoniana Lamb. under nitrogen VS control treatment in a warm-temperate forest in central China

Huang Jianguo , Zhang Shaokang
South China Botanical Garden of the Chinese Academy of Sciences

Knowledge on the intra-annual wood formation under nitrogen (N)-additive treatment is critical to better understand how trees are responding to and coping with an increasing atmospheric N deposition within the context of global change. We established a two-year N-additive VS control comparative experiment to monitor wood formation of Pinus massoniana in a warm temperate forest in Jigongshan National Natural Reserve in central China from 2014-2015. Micro-sampling approach was used to weekly collect the samples from stem at breast height (1.3 m) above ground and a regular procedure in the lab was then followed to obtain xylem formation parameters during the two growing seasons. Differences between N-additive and control treatment were also investigated through the general linear model. We found that wood formation process of Pinus massoniana may be well described by the Gompertz function as previously reported for other species, and the duration of wood formation is longer in this warm-temperate forest, starting from

the end of March to the end of October. We also found more cambium cells in control treatment than N-additive treatment during the two growing seasons, but more lignified cells between July and October in 2015 with N-additive treatment than control treatment.This may indicate that N-addition might immediately inhibit cambium cell division in early spring, but might have a delay yet positive effect on cell wall lignification, as shown by more cells in wall lignification phase observed in 2015. Our results may contribute to a better understanding of tree physiology and wood quality for sustainable forest development under global change.

The temporal changes of terpenoids synthase in Pinus massoniana feeding by Monochamus alternatus

Chen Ruixu[1,2], He Xuanyu[1,2], Zhang Beibei[1,2], Chen Changyu[1,2], Hao Dejun[1,2]
1. Co-Innovation Center for the Sustainable Forestry in Southern China, Nanjing Forestry University
2. College of Forestry, Nanjing Forestry university

Conifer trees have evolved multiple constitutive and inducible resistance mechanisms under the pressure of herbivous insects and pathogen. The inducible resistance mechanism occured only after the plant been damaged. In conifers, the induced defense is usually represented by the formation of traumatic resin ducts in phloen and xylem tissue and the accumulation of terpenoids. The sawyer beetle, Monochamus alternatus Hope (Coleoptera: Cerambycidae) is a serious pest of pine trees in China. It is a vector for the transmission of the pinewood nematode, B. xylophilus. Masson pine (P. massoniana) is a widely planted in Asia and an important source of timber and oleoresin in South China. Insect pests and microbial pathogens are significant threats to P. massoniana, especially in forestry plantations. In this study, transcriptome sequencing and qRT-PCR are used to explore the transcriptome of induced terpenoids synthase and their temporal changes in P. massoniana after M. alternatus feeding. Theses results will be useful to future studies on genetic control of induced defence mechanisms in P. massioniana.

M. alternatus adults were confined on a seedling stem of two year old clonal saplings of P. massoniana. Three trees per treatment were sampled at 0 (no treatment) and at 0.5, 1.5, 3, 9, 15 and 30d. The transcriptom sequencing were done by Illumina Hiseq2000. 63572237434nt bases were generated totally. In the results of assembly, 109294 unigenes were detected, total length for unigenes was 124838903 nt, average length was 1142 nt，N50 was 1948 nt. Some enriched pathway related with terpenoids synthesis were found, such as "Terpenoid backbone biosynthesis", "Limonene and pine degradation", "Ubiquinone and other terpenoidquinone biosythesis", "Sesquiterpenoid and triterpenoid biosynthesis"、"Monoterpenoid biosythesis". The number of enriched genes increased and reached the top in 0.5-3d. To evaluate the reliability of the RNAseq data, we choose 7 monoterpenoid synthase, 6 sequiterpene synthase and 1 diterpene synthase from these pathways. The results showed most of the monoterpenoid synthase genes quickly responded to their highest level in the 0.5 and 1 d readings. Among the sesquiterpene synthases, delta-selinene synthase and caryophyllene synthase reached peaks in the first 1.5-3 d. Longifolene synthase and (-)-ent-kaurene synthase reached maximums in 15 d and 30 d respectively. Dieterpene synthese did not show a rising trend and declined at 9 d. The expression level of the terpenoids synthases all fall and tended steady after the peak, but still higher than the control ones. The results were consistent with the previously study about terpene accumulation and resin duct formation induced by M. alternatus feeding. Further studies, using the transcriptomes described here, could focus on TPSs functional analysis and subcellular localization.

Identification of two CiGADs from Caragana intermedia and their responses to abiotic stresses and exogenous ABA

Ji Jing, Zheng Lingyu, Yue Jianyun, Jiang Zeping, Shi Shengqing
State Key Laboratory of Tree Genetics and Breeding, Research Institute of Forestry, Chinese Academy of Forestry

Glutamate decarboxylase (GAD), as a key enzyme in γ-aminobutyric acid (GABA) shunt, catalyzes the decarboxylation of L-glutamate to form GABA, which is attracting much more interests focusing on the roles of carbon nitrogen metabolism, stress responses and signalling in higher plants. In this study, two full-length cDNA encoding GAD (designated as CiGAD1 and CiGAD2) was isolated and characterized from Caragana intermedia, an important nitrogen-fixation legume shrub. Multiple alignments showed that both two CiGADs contained conserved PLP domain and calmodulin (CaM)-binding domain in the C-terminal region, and they were more closely related to legume plant soybean revealed by phylogenetic analysis. Tissue expression demonstrated that CiGAD2 showed far higher transcript level than CiGAD1 in bark, suggesting CiGAD2 might play a role in secondary growth of woody plants. Several stress treatments (NaCl, ZnSO4, CdCl2, high/low temperature and dehydration) significantly increased two CiGADs transcript levels except CiGAD2 in Cd stress. Surprisingly, Zn and heat stresses showed considerable influences on CiGAD1 transcription levels over 74.3- and 218.1-fold increase in roots and leaves, respectively. Moreover, two CiGADs expression had obvious induction in accordance with GABA accumulation by the continuous 24-hour salt treatments; of these, ABA participates in the regulation of these two CiGADs expression during salt stress happening. These results would benefit the future study of GADs' role in carbon nitrogen metabolism and signal transduction in plants' response to environmental stresses.

Physiological potential of bamboo in urban landscaping

Clarisse Ann Erespe, Marilyn Combalicer, Portia Lapitan
University of the Philippines Los Baños

Plants are important in the urban environment not just because of its aesthetic value but because it gives people conducive environment to live in. Bamboo species are one of the plant species that are usually used for urban landscaping. However, because of the pollution brought about by the urban environment, the physiological processes of these plants are affected. The objective of this study is to assess the physiological potential of Bambusa vulgaris var striata, Bambusa vulgaris and Schizostachyum brachycladium in urban landscaping by assessing their photosynthesis, water absorption, and transpiration. The physiological potential is defined as assessing the capacity of a species to adapt its physiology or functions and processes to a certain environment. The parameters include in this study are the leaf weight, leaf areas and some physiological characteristics (photosynthesis, absorption, transpiration) compared in two environmental conditions, the urban and forest environment. B. vulgaris var striata is shown to be the most capacitated species among the three species because it is the least differentiated among the physiological rates and other parameters used. S. brachycladium showed to be the least capacitated for adapting its physiological processes in urban landscaping. Therefore, B. vulgaris var striata can be a recommended species for planting in urban areas.

Clonal propagation of flacourtia indica for ensuring quality planting materials and sustainable supply of edible fruits in natural disasters

Md.Alamgir Kabir, AKM Mostafa Zaman, MH Mehedi Khan, A.T.M. Rabiul Alam, Md. Masudur Rahman, S.M. Hemayet Jahan, Muhammad Zahid Al Mamun (Patuakhali Science and Technology University)

The present study was carried out at the Agriculture research field, Patuakhali Science And Technology University(PSTU), Patuakhali, from March, 2015 to April, 2016 to explore the domestication potential and to evaluate the rooting performance of Flacourtia indica (katabohori), a wild fruit species in Bangladesh, through clonal propagation by stem cutting under 3 different doses of rooting hormone IBA (Indole Buetaric Acid) and planted in the perforated plastic tray filled with coarse sand and gravel placed in the non-mist propagator. The experiment was laid out following a Randomized Complete Block Design (RCBD) with 4 treatments and 4 replications (blocks). The treatments were T0= control, T1 = 0.2% IBA, T2 = 0.4% IBA, T3 = 0.8% IBA. The rooting ability of cuttings was significantly influenced by the application of IBA. The results showed that the highest rooting percentage (100) and maximum root number (8) of Flacourtia indica stem cuttings were obtained from the cuttings treated with 0.4% IBA followed by 0.2% IBA where as the longest root length (8.998 cm) was recorded with 0.2% IBA followed by 0.4% IBA. Findings of the present study reveal that the plant species is highly amenable for clonal propagation by stem cuttings using low-cost non-mist propagator. Considering both rooting percentage and root number, 0.4% IBA treatment of stem cuttings may be recommended for mass production of quality planting stocks for the domestication of the species in homestead agroforestry or in fruit orchards to provide edible fruit to rural poor people of natural disaster vulnerable Bangladesh.

Session CSF-07 (88-5): Multi-target tree breeding and molecular techniques for sustainable forest management in future

The pan and core genome of *Populus trichocarpa*

Gerald Tuskan
BioSciences Division, Oak Ridge National Laboratory, Oak Ridge TN 37831

The genetic diversity of a species is the sum of the diversity found in all individuals of that species. One way to estimate the diversity of species is by resequencing diverse accessions and aligning the reads to a reference genome. While this approach readily identifies SNPs and small indels with respect to a reference genome, it underestimates total genomic diversity contained within a species because highly divergent regions align poorly to the reference and any sequence not found in the reference will be missed entirely. There is a considerable amount of structural variation including copy number variants (CNVs) and presence/absence variants (PAVs), which alter the total amount of genomic sequence found in individuals. Thus, the true extent of diversity within a plant species is largely unknown. *De novo* genome assemblies and annotation can be used to more accurately estimate the true genomic diversity within a species. Pan-genomes in other plant species have been created before but at a smaller scale. Previous studies used around 50 genomes to create the pan-genome. Here we present one of the largest studies with more than a thousand genotypes of *Populus trichocarpa*. We applied both approaches of reference-based alignment, as well as de-novo assembly of unmapped reads, to create a pan-genome that contains all the diversity found in the accessions sequenced. Analysis of this data yielded a high-confidence *Populus trichocarpa* pan-genome that includes more 25,000 additional gene models relative to the reference. We have also used RNA Sequencing for generating expression profiles of individual accessions, with ca. 75% of the new gene models having expression evidence. We have used this RNA-Seq data to generate the pan-transcriptome profile of *Populus trichocarpa* and have identified new splice-site variants, found alternate exon-intron structures within the reference gene models and promoted alternate splice-site variants as the primary gene model.

Development of genetic technology for improvement of forest production

Li Laigeng
Institute of Plant Physiology and Ecology, Chinese Academy of Sciences
300 Fenglin Rd, Shanghai, 20032, PR China

In order to protect natural forest for sustaining a healthy ecological environment, supply of forest products is mainly dependent on the development of efficient artificial plantation. To breed genetically elites of trees is a key basis for highly productive plantation. As trees grow long generation with low efficiency of controlled hybrid selection, tree improvement calls for new technology for facilitating elite tree generation.
Advances of molecular genetics and genomics open an avenue for genetic manipulation and genomic editing which allow concise-targeted and efficient tree improvement. Lignin and cellulose are primary components of wood and play a critical role in determining wood property. In our studies, through manipulation of lignin or cellulose biosynthesis genes, the lignin content, monolignol (S and G units) composition, or cellulose characters can be engineered to innovate tree germplasms for breeding elite-objective trees. Furthermore, the thickness of wood cell wall, another key trait of wood property, can also be modified to generate trees with desired wood properties. Our results demonstrate that efficient tree improvement can be achieved by applying new genetic technology.

Genomes and evolutions of the endangered and widespread ironwood species

Yang Yongzhi , Liu Jianquan
Sichuan University/Lanzhou University

Ironwood species, known for their hard woods, provide an especial resource in our life. But the mechanism of the hard wood formation remains unknown. One of the ironwood species with extremely small population with only five wild individuals also serves as the ideal system to examine genetic consequences of the endangered ironwood species. Here, we report the high-quality genome assemblies of the endangered *Ostrya rehderiana* (366.2 Mb, scaffold N50 = 2.3 Mb) and the widespread *O. chinensis* (386.6 Mb, scaffold N50 = 762.5 Kb). Both assembled genomes cover more than 94%/96% of the estimated genomes (386 Mb/400 Mb) and harbour 27,831/31,152 predicted protein-coding genes respectively. A total of 756 and 1,310 gene families were respectively expanded in *O. rehderiana* and *O. chinensis*. These gene families were mainly associated with the interaction with their local environments, such like signal transduction and ion channel. 606 gene families were expanded in the ancestor lineage of *O. rehderiana* and *O. chinensis*, some of which are related to the lignin metabolic process underlying the ironwood formation. The endangered *O. rehderiana* shows a lower heterozygosity and sequence diversity (π) and higher levels of deleterious mutations and inbreeding than the widespread *O. chinensis*.

Sequencing the willow genome distinguishes the divergent evolution between the sister genera of *Salix* and *Populus*

Yin Tongming
Co-Innovation Center for Sustainable Forestry in Southern China,
College of Forestry, Nanjing Forestry University

Salix (willows) are dioecious wood plants, belonging to the Salicaceae family. The genus *Salix* comprises about 350–500 species that are widespread in the Northern and Southern hemispheres, excluding Australasia and New Guinea (Argus 1997). Willows show considerable variation in growth form, crown architecture, and size, in forms of shrubs, sub-trees and large trees (Newsholme 1992; Perdereau et al. 2013). Many willow species can achieve high biomass yields over short growth cycles with low agrochemical input (Brereton et al. 2010), thus they are considered promising sources of bioenergy. Besides using as an energy crop, willows have been grown and used for a variety of purposes, including phytoremediation, nutrient management, and stream bank stabilization (Smart et al. 2005).

S. suchowensis is a shrub willow species endemic to China. It has been using for basketing for thousand years. This willow is typically two meters tall and normally reaches sexual maturity within one year (Liu et al. 2013). These biological characteristics make it as a desirable model system for different aspects of genetic studies on woody plants. The whole genome of *S. suchowensis* was sequenced (Dai et al. 2014), and the assembled sequence scaffolds were mapped along each chromosome (Hou et al. 2016). *Salix* and *Populus* (poplars) are sister genera of the Salicaceae family. Comparison of their genomes revealed that the two lineages originated from a common tetraploid ancestor, whose crown appeared around 58.08 ± 0.11 million years ago. About six million years later, two major inter-chromosomal rearrangements distinguished the karyotypes of willow and poplar (Hou et al. 2016). Mapping the gender locus in willow and poplar revealed that different autosomes had evolved into sex chromosomes during the evolutionary process (Hou et al. 2015), and evolving of sex chromosome took place after the divergence of these two lineages. The availability of a willow genome is highly desirable for functional genomics studies of woody plants, and will help maximize the efficiency of breeding new cultivars to enable use of willow as an energy source crop.

Somatic embryogenesis and emblings productivity in industrialization scale of Hybrid *Liriodendron* in China

Chen Jinhui, Huang Zhang Rong,Li Huogen,Xu Jin,Bian Liming,Zhen Yan,Wang Guangping , Lu Ye,Shi Jisen
College of Forestry, Nanjing Forestry University, Nanjing 210037 JS, China

Interspecific hybridization within the genus of *Liriodendron* have shown very strong heterosis on the traits of growth, biotic and abiotic resistance, and it was in large amount of demanding in planting stocks marketing. We developed a series of patents to develop somatic embryogenesis and emblings (plants regenerated from somatic embryos) regeneration system with immature embryos from superior hybrid combinations. The breakthroughs in this system were included in high-frequency inducing and proliferation of somatic embryonic cell lines, synchronization development regulation and developmental process accelerating of somatic embryo, long term embryogenic ability maintaining technology of somatic calli. The long-term induction rate, developmental synchronization rate, the germination rate of somatic embryo was 60%, 95% and

95%, respectively. Each somatic plant regeneration cycle was around 2 months, and ~400,000 high quality emblings could be generated by per Liter suspending somatic embryogenic mass. Based on this series of invention patents, a manufacturing factory was first established for somatic emblings propagation of hybrid *Liriodendron* with industrialization scale, the productivity is ~20 million plants, annually.

High-density genetic map of Ginkgo biloba based on high-throughout sequencing

Liu Hailin , Dai Xiaogang ,Cao Fuliang,Yin Tongming
Nanjing Forestry University

Ginkgo biloba is the sole living member of the Ginkgoalean clade, dating back to early Permian period, approximately 280 million years ago. It is a dioecious species native to China with medicinally and phylogenetically important characteristics while genomic resources were very limited due to its complicated genome. In this study, we constructed a complete genetic map of an individual tree using RAD-SLAF sequencing of 94 haploid megagametophytes. A total of 12,263 polymorphic SLAF markers have been mapped to 12 linkage groups constructed by HighMap, equivalent to the number of haploid G. biloba chromosomes (2n=24) with a total coverage of 1,671.77 cM. The framework map contained 1976 polymorphic markers with an average of 0.89 cM intervals. Our genome coverage was estimated to be nearly complete with a framework marker interval of 20 cM. It should provide a useful framework for merging existing Ginkgo maps and adding multiallelic markers as they become available. In addition, this high-density map provides an important resource for breeders and geneticists for subsequent quantitative trait locus mapping in families and will enable comparative studies across species, as well as improve the G. biloba genome sequence assembly.

Genome dynamics in willow and poplar after the ancestral “salicoid” genome duplication

Hou Jing ,Dong Zhongyuan ,Yin Tongming
Nanjing Forestry University

Populusand Salix are sister genera in the Salicaceae family. In both lineages extant species are predominantly diploid. Genome analysis previously revealed that the two lineages originated from a common tetraploid ancestor. In this study, we conducted syntenic comparison of the corresponding 19 chromosome members of the poplar and willow genomes. It revealed that almost every chromosomal segment had parallel paralogous segment elsewhere in the genomes, and the two lineages shared a similar syntenic pinwheel pattern for most of the chromosomes, which indicated that the two lineages diverged after the genome reorganization in the common progenitor. The pinwheel patterns showed distinct differences for two chromosome pairs. Further analysis detected two major inter-chromosomal rearrangements that distinguished the karyotypes of willow and poplar. Scientists have suggested that Populus is evolutionarily more primitive than Salix. Therefore, we propose that after the “salicoid” duplication event, fission and fusion of the ancestral chromosomes first give rise to the diploid progenitor of extant Populus species. During the evolutionary process, poplar chromosome I broke into two parts, the lower portion was joined with poplar chromosome XVI, giving rise to willow chromosome I, whereas the upper portion gave rise to willow chromosome XVI. This study contributes to an improved understanding of genome divergence after ancient genome duplication in closely related lineages of higher plants.

Isolation and identification of the main pathogen fungi from olive in south Gansu

Liang Xiaogang[1], Yin Tongming[1]
1. Nanjing Forestry University
2. Key Laboratory of Forest Genetics & Biotechnology
3. Jiangsu Key Laboratory for Poplar Germplasm Enhancement and Variety Improvement

Olive has developed into a riching pillar industry for the people in south Gansu mountain areas, but the constant enlargement of its cultivated areas and extensive single management techniques entail diseases and insect pests. To make clear the main pathogen fungi species of olive in south Gansu, 10 disease samples from two counties of southern Gansu were collected and isolated. Pathogenic fungi by morphological and ribosome rDNA ITS (Internal transcribed spacer） areas sequences analysis identification. PCR amplification products of ITS rDNA of the isolated strains obtained were sequenced. It is consistent with the morphological identification results that through the correlation analysis of ITS rDNA sequences. The results of identification showed that main pathogen fungi from olive in south Gansu were Capnodium eleaophilum, Colletotrichunm gloeosporioides and Spilocaea oleaginea. They were isolated in leaves and fruits. We attempted to isolate and identificate pathogenic fungi by using susceptible leaves, stems and fruits from olive in south Gansu mountain areas as experimental material. Based on our preliminary results, definite the main pathogenic fungi from olive in south Gansu, the research provide a effective theoretical basis to prevent and treat diseases of the olive.

The induction of embryonic callus from leaves and stems of Salix suchowensis

Wu Qiuyan[1], Yin Tongming[1]
1. Nanjing Forestry University
2. Key Laboratory of Forest Genetics & Biotechnology
3. Jiangsu Key Laboratory for Poplar Germplasm Enhancement and Variety Improvement

Somatic embryogenesis is widely recognized as an effective approach for plant regeneration, which has been used successfully in some species. Embryonic calluses are the key to plant somatic embryogenesis. However, since similar researches on willow are rarely reported. For these reasons, we attempted to obtain embryonic calluses by using leaves and stems from Salix suchowensis as explants incubated in Murashige and Skoog's media (MS) containing different types and levels of plant growth regulators. We eventually determined two optimal combinations, 0.1 mg l–1 N-6-benzyladenine(6-BA) and 0.1 mg l-1 2,4-dichlorophenoxyacetic or 0.1 mg l–1 N-6-benzyladenine (6-BA) and 0.6 mg l-1 2,4-dichlorophenoxyacetic. The sucrose concentration of the medium is 30 g l-1. Immature leaves and stems were cultured under these conditions, calluses occurred in the containers after 30-day incubation. According to the histological observation, the existence of embryonic cells in calluses was detected, and also we noticed that those embryonic cells and non-embryonic cells can exist in one single callus simultaneously. This research provides feasibility for rapid in vitro multiplication method of Salix suchowensis, which is a theoretical basis for set up a steady regeneration system for it.

Genetic diversity analysis and primary core collection of Catalpa bunge germplasm based on SSR markers

Fang Lecheng, Xia Huimin,Dai Xiaogang
Nanjing Forestry University

Construct core collection has been well accepted as a useful way to improve efficiency of conserve and manage species germplasm. In this research, SSR locations provided by Beijing Institution of Forestry were used for SSR primer design with software Primer Premier 5.0, we collected 192 Catalpa bunge germplasm resource for genetic diversity analysis and genetic relationship research. 13 pairs of SSR primers were selected in the preliminary experiment, all of the 192 samples were amplified by these 13 pairs of primers and found 89 alleles, The average effective number of allele(Ne) was 3.7959, average of Shannon's diversity index(I) was 1.3800; Nei's genetic diversity(H) average number was 0.6677. Analysis genetic distance of 192 Catalpa bunge samples with MEGA6.0, and construct the dendrogram of Catalpa samples by cluster analysis. With SSR markers and the sampling stratagy of multiple cluster binding site preferential, we primarily construct 4 core sample groups with different numbers. In this 4 groups, 46 core collection of the total 192 collected Catalpa trees were compared by the parameters including the number of allele, effective number of allele, Shannon's index and Nei's genetic diversity. The core collections retained 23% of the original collections.

The complete chloroplast genome structure of salix suchowensis

Sun Congrui,Yin Tongming
Nanjing Forestry University

Salix suchowensis is a well-known native shrub willow species in the north of china. This study separated the chloroplast(cp) genome from the whole genome of *salix suchowensis* which has been sequenced, the main analysis about the structure of the cp genome is as follows. The complete circular chloroplast genome size was 155,508bp in length with a quadripartite structure containing two single copy regions, a large single copy region (LSC,84385bp) and a small single copy region (SSC,16209bp) separated by inverted repeat regions (IRs,27457bp). The chloroplast genome encodes 112 unique genes, including 78 protein-coding genes, 30 transfer RNA genes, and 4 ribosome RNA genes. In the cp genome, 15 tandem repeats, 16 forward repeats and 5 palindromic repeats were detected. A total of 188 perfect microsatellites were also detected through simple sequence repeat (SSR) analysis and they were distributed unevenly in the cp genome. We also compared the cp genome structure and gene order to those of four *rosids* species, and the result indicated that IR boundaries of the *Salix suchowensis* cp genome has a expand phenomenon. Maximum Likelihood and Neighbor Joining analysis with 31 taxa angiosperm of 67 genes were applied to build phylogenetic tree. The study will be greatly helpful for understanding the evolution history of S*alicaceae* cp genome.

The complete chloroplast genome sequence of Glyptostrobus pensilis: insights into dynamics of chloroplast genome rearrangement in Cupressophytes and Pinaceae

Hao Zhaodong[1],Chen Jinhui[1],Shi Jisen[1]
1 Key Laboratory of Forest Genetics and Biotechnology, Ministry of Education, Nanjing Forestry University, Nanjing, China

Glyptostrobus pensilis, belonging to the monotypic genus Glyptostrobus (Family: Cupressaceae), is an ancient conifer that is naturally distributed in low-lying wet areas. Here, we report the complete chloroplast (cp) genome sequence (132,239 bp) of G. pensilis. The G. pensilis cp genome is similar in gene content, organization and genome structure to the sequenced cp genomes from other cupressophytes, especially with respect to the loss of the inverted repeat region A (IRA). Through phylogenetic analysis, we demonstrated that the genus Glyptostrobus is closely related to the genus Cryptomeria, supporting previous findings based on physiological characteristics. Since IRs play an important role in stabilize cp genome and conifer cp genomes lost different IR regions after splitting in two clades (cupressophytes and Pinaceae), we performed cp genome rearrangement analysis and found more extensive cp genome rearrangements among the species of cupressophytes relative to Pinaceae. Additional repeat analysis indicated that cupressophytes cp genomes contained less potential functional repeats, especially in Cupressaceae, compared with Pinaceae. These results suggested that dynamics of cp genome rearrangement in conifers differed since the two clades, Pinaceae and cupressophytes, lost IR copies independently and developed different repeats to complement the residual IRs.

Analysis of codon usage patterns in *Ginkgo biloba* revealed a codon usage tendency from A/U ending to G/C ending

He Bing , Dong Hui , Xu Li-an
Co-Innovation Center for Sustainable Forestry in Southern China, Nanjing Forestry University, Nanjing, 21003

As one of the most ancient tree species, the codon usage pattern analysis of *Ginkgo biloba* is a useful way to understand its evolutionary and genetic mechanisms. Several studies have been conducted on angiosperms, but none on gymnosperms. Based on RNA-Seq data of the *G. biloba* transcriptome, amount to 17,579 unigenes longer than 300 bp were selected and analyzed from 68,547 candidates. The codon usage pattern was generally preferred to using A/U ending codons, which showed an obvious gradient from gymnosperms to dicots and monocots. Meanwhile, analysis on high/low expression unigenes revealed that high expression unigenes tended to use G/C ending codons together with more codon usage bias. Variation on unigenes with different functions suggested that unigenes involving in environment adaptation were preferred to use G/C ending codons with more usage bias, and these results were consistent with the conclusion that the formation of *G.biloba* codon usage bias was dominated by natural selection. To our knowledge, no systematic analysis on gymnosperm codon usage pattern has been reported, and the analysis based on *G.biloba* high-throughput data could be an effective supplement to the codon usage bias discipline in gymnosperms.

Construction of dense genetic maps in poplar using Whole-Genome and RAD sequencing technologies

Tong Chunfa, Mohaddeseh Mousavi, Liu Fenxiang,Tao Shentong,
Wu Jiyan ,Li Huogen , Shi Jisen
College of Forestry, Nanjing Forestry University, Nanjing 210037, China

We demonstrated a strategy for constructing dense linkage maps in forest trees by combining the use of RAD-seq (restriction site-associated DNA sequencing) and whole-genome sequencing technologies. We performed RAD-seq of 150 progeny and whole-genome sequencing of the two parents in an F_1 hybrid population of *Populus deltoides* × *P. simonii*. Two rough references were assembled with the whole-genome sequencing reads of the two parents separately. Based on the parental reference sequences, a total of 3,442 high-quality SNPs were identified that segregate in the ratio of 1:1. The maternal linkage map of *P. deltoides* was constructed with 2,012 SNPs, containing 19 linkage groups and spanning 4,067.16 cM of the genome, while the male map of *P. simonii* consisted of 1,430 SNPs and the same number of linkage groups with a total length of 4,356.04 cM. Collinearity between the parental linkage maps and the reference genome of *P.*

trichocarpa were also investigated. Compared with the result on the basis of the reference genome, our strategy could identify more high-quality SNPs and generate the parental linkage groups that nicely match the karyotype of *Populus*. The strategy could be applied to constructing high-density genetic maps in forest trees regardless of an existing reference genome.

Effects of parents' genetic-distance on offsprings' growth performance in *Pinus massoniana*

Ni Zhouxian, Bai Tiandao ,Xu Li-an
1. Co-Innovation Center for Sustainable Forestry in Southern China, Nanjing Forestry University, Nanjing, 210037;
2. Forestry college of Guangxi University, Nanning, 530000

Based on the parents and open-pollinated(OP) progeny populations(which were planted in 1995/1996/1997) of cloning seed orchard of the *P.massoniana*,we want to find the relationship between genetic-distance(GD) and the growth stability of progeny between years.According to the growth stability of OP famlies between years,we respectively screened 10 most stable families(stable groups(SG)) and most unstable families(unstable group(USG)).And,we used SSR to find their parents and analyze GD of Male-Female.The GD had significant differences between groups,and the GD of SG(mean=0.4156) was less than USG(mean=0.5778).Besides,the proportion of parents(GDs<0.5) of SG(75.00%) was more than USG(33.83%),and the proportion of parents(GDs>0.7) of SG(8.13%) was less than USG(28.57%).In summary,the GD of USG was more than SG,and the growth of USG's progeny had more difference.What's more,the parents were divided into 3 groups(better(BG), medium(MG), worse(WG)) according to the growth performance of offspring.The tendency of mean GDs of groups was BG(0.5473)>MG(0.4870)>WG(0.4585).The the proportion of parents (GDs<0.5) of WG (62.12%)was maximum,and the BG (56.76%)was least.Despite the BG(22.97%) and WG(21.21%) have similar proportion of parents(GDs>0.7),the progeny of BG had superior performance and WG are worse.In conclusion,the less the GD of parents,the more stable growth performance of progeny between years.Also,we would find some offsprings with excellent performance when GD of their parents litter than 0.7.

Genetic analysis of populations on *Ginkgo biloba.* using SSR markers

Zhou Qi ,Mu Kemin ,Xu Li-an
Co-Innovation Center for Sustainable Forestry in Southern China,
Nanjing Forestry University, Nanjing, China

Ginkgo biloba linn, as the "living fossil", is the unique specie in Ginkgopsida. After the Quaternary glaciations, it has become the "native species" of China. To study the population genetic structure and genetic diversity of G. *biloba*, 8 populations from Guizhou, Zhejiang, Jiangsu provinces had been tested by simple sequence repeats (SSR). The results showed that 183 alleles were amplified in 229 individuals (181 ancient trees and 48 planted trees) using 22 SSR primers. The genetic diversity (*Nei*') of Ginkgo at specie level was 0.793, which meant the higher level of genetic diversity. The variation among populations was 9.1% (F_{st}=0.091), and there were no significant correlations between genetic differentiation and geographic distance. More analysis of different alleles especial the rare alleles showed that Tianmu mountain population and Wuchuan population had more unique alleles, and there were genetic differences between populations in Zhejiang and Guizhou province. As a conclusion, Tianmu mountain in Zhejiang province and

Wuchuan in Guizhou province may play the role of refuge in the Quaternary glacial period, and Panxian population comes from an ancient population. The *Ginkgo* resources in the three areas should better be in situ conservation.

The study on geographic variation for growth traits and wood properties of Chinese fir

Che Jinke , Bian Liming ,Shi Jisen
College of Forestry, Nanjing Forestry University

Chinese fir (Cunninghamia lanceolata （Lamb.）Hook.) is widely planted in southern China. The natural distribution is covered all provinces south of Qinling Mountain, and the variation within species is abundant. 31 Chinese fir provenances were included in this study. Significant differences among Chinese fir provenances were found at the diameter at breast height (DBH), wood stiffness and wood density at the age of 34. Using correlation and trend surface analysis, we found there were strong correlations between the growth and wood qualities traits, and geographic latitude and longitude, and significant geographical variation trends in the direction of longitudinal and latitude. The DBH had an increasing trend from west to east. Wood density and wood stiffness showed increasing trend from west to east and decreasing from three centers of Qinling Mountains, Dabie Mountains and Wuyi Mountains to south and north, The study shows geographical variation pattern of Chinese fir on growth traits is cline, and on wood properties both cline and ecotype.

Molecular cloning, expression analysis and subcellular localization of four *DELLA* genes from hybrid poplar

Liu Sian ,Xuan Lei ,Xu Li-An ,Huang Minren , Xu Meng
Nanjing Forestry University

Gibberellic acid (GA) signaling regulates diverse aspects of plant growth and developmental processes. The DELLA repressors of GA signaling are named for an N-terminal conserved DELLA domain. In this study, four genes encoding DELLA proteins, PeRGA1, PeRGA2, PeGAI1 and PeGAI2, were isolated and characterized in poplar. A gene structural analysis revealed that the DELLA genes were all intron-free. Multiple protein sequence alignments revealed that these proteins contained seven highly conserved domains: the DELLA domain, the TVHYNP domain, leucine heptad repeat I (LHR I), the VHIID domain, leucine heptad repeat II (LHR II), the PFYRE domain, and the SAM domain. Temporal expression patterns of these genes were profiled during the adventitious root development of poplar. The four DELLA genes were expressed in root, stem and leaf in a dynamic manner. The subcellular localization demonstrated that these DELLA genes were mainly localized to the nucleus. These results suggest that the four DELLA genes may play diverse regulatory roles in the adventitious root, stem and leaf development of poplar, and contribute to improving our understanding of conserved and divergent aspects of DELLA proteins that restrain GA signaling in various species.

Population variations of leaf morphology and active ingredients in *Ginkgo biloba*

Mu Kemin , Xu Li-an
Co-Innovation Center for Sustainable Forestry in Southern China, Nanjing Forestry University, Nanjing, China

Rencent years witnessed a remarkable improvements of the status of Ginkgo's leaves value. To study genetic variation of different leaf traits within and between the populations, the leaf traits of the 298 grafted clones of ancient (big) Ginkgo trees collected from 10 localities of 4 provinces within the main distribution areas were detected, and the contents of the main active ingredients were measured by High Performance Liquid Chromatography(HPLC). The result showed there were significant differences among the leaf traits between populations. The leaves from southwest China were relatively small, and owned less contents of flavonoids and lactones; The leaves from east China were relatively large, and owned more contents of flavonoids and lactones and less contents of ginkgolic acid. All of the lactones characters had significant negative correlation with altitude. As a conclusion, the ancient Ginkgo trees distributed in China show a high level of diversity and abandunt geography variations respect of leaf morphology and active ingredients. The results metioned above could provide evidences for population selection. Based on population selection, more attention should be paid to selectting within populations.

RNA-seq of *Tamarix chinensis* on salt stress and differentially expressed gene analysis

Wang Jianwen, Xu Meng, Xu Li-an
Co-Innovation Center for Sustainable Forestry in Southern China,
Nanjing Forestry University, Nanjing, 210037

Tamarix chinensis, being a salt-tolerant tree species, is good material for examining salt-tolerance genes of plants and tolerance mechanisms. 106463 Transcripts and 59,331 unigenes were assembled by transcriptome sequencing of *T*. *chinensis* roots under sodium chloride (NaCl) stress using Illumina HiSeq 2000. Of these unigenes, 45.58% were annotated successfully in 7 major sequence databases. 9,886, 8,153 and 19,938 unigenes were subdivided into 28 KOG (EuKaryotic Orthologous Groups) groups, 29 KEGG (Kyoto Encyclopedia of Genes and Genomes) pathways and 47 GO (Gene Ontology) terms, respectively. 1251 differentially expressed genes (DEGs) were identified by FPKM analysis. The DEGs were classified into ten expression patterns according to the fold change of FPKM. From the 59,331 unigenes, we predicted about 3000 general NaCl-stress responsive genes. Especially, we predicted several specific salt-tolerance candidate genes by comprehensive analysis of DEGs.Given all the responsive genes were potential salt-tolerance determinants, we described their roles on the frame of salt signaling pathway and this could be a systematic guide for following salt tolerance studies.

Screening and validation of reference genes using quantitative RT-PCR analysis in *Ginkgo*

Huang Shujing,Wang Na,Xu Li-an
Co-Innovation Center for Sustainable Forestry in Southern China, Nanjing Forestry University, Nanjing, China

With reference to other species commonly used reference genes, based on 454 Sequencing EST sequence of *Ginkgo*, 23 candidate reference genes for real-time quantitative PCR were chosen. Their expression stability of four different samples (root, stems, leaves and buds) were evaluated, and the results on the analysis of expression of different tissue samples (root, stems and leaves) showed that TUA1 could be recommended as the best reference genes, followed by 40S and CYP genes. In samples of buds at different developmental stages, EF1α exhibits the highest stability, therefore we recommend EF1α as the best reference genes, followed by PDA1 and CYP genes. In leaf samples at different developmental stages, CYP and EF1α are the suitable reference genes. In leaf samples that underwent salt stress, TUA5, CYP, and EF1α, showed better stabilities, and were chosen as homogenized reference genes in salt stress leaf samples. Comprehensive analysis of all samples, CYP and EF1α in all samples showed high stability, and can be used them as a general reference gene in the samples involved in this study.

Floral nectary morphology and proteomic analysis of nectar of *Liriodendron tulipifera* Linn.

Zhou Yanwei ,Shi Jisen ,Chen Jinhui
Key Laboratory of Forest Genetics and Biotechnology, Ministry of Education, Nanjing Forestry University, Nanjing, 210037, China
Co-Innovation Center of Sustainable Forestry in Southern China, College of Forestry, Nanjing Forestry University, Nanjing, 210037, China

Nectar secretion is an evolutional adaptation of many angiosperms to attract pollinators especially flying insects - for outcrossing, and nectar serves as a nutrient reward and energy source for pollinators. Recent studies have demonstrated that nectar also has defensive functions against microbial invasion. In this study, we first characterized the nectary structure of L. tulipifera by morphological observation, the nectary of L. tulipifera was positioned in a more colorful and accessible area on the petals and secreted considerably more nectar, which was distinctly different from other genus in Magnoliaceae. Then the nectar was analysed by two-dimensional gel electrophoresis and liquid chromatography–tandem mass spectrometry, which led to identification of 42 nectar proteins involved in various biological functions. Bioinformatic analysis was then performed on an identified novel rubber elongation factor (REF) protein in L. tulipifera nectar. The protein was particularly abundant, representing ~60% of the major bands of 31 to 43 kDa, and showed high, stage-specific expression in nectary tissue. The REF family proteins are the major allergens in latex. We propose that REF in L. tulipifera nectar has defensive characteristics against microorganisms.

What perceptions and contexts underpin Ghana's bioEthical challenges in the 21 century?

Akwasi Asamoah
Kwame Nkrumah University of Science and Technology

Gaps which often hinder the prosecution of the biotechnology agenda in developing economies as Ghana are broadly technological, organisational and orientational in nature. More important than these gaps are the entrenched perceptions which strongly underpin these gaps. As whimsical and diverse as these perceptions may be across key stakeholders (government, private investors, professionals and NGOs), they sure play an important role in the narrowing of gaps in developing agro-based economies as Ghana's. The earlier these perceptions are concertedly and unanimously identified and addressed through consensus building and dialogue, the quicker Ghana can be brought to the path to narrowing or closing yawning gaps in its biotechnology agenda for the timely meeting of its sustainable development goals.

Analysis of genetic diversity in schima superba plus tree germplasms by SSR markers

Yang Hanbo[1,2], Zhang Rui [1,2], Zhou Zhichun [1,2]
1. Research Institute of Subtropical Forestry, Chinese Academy of Forestry
2. Zhejiang Provincial Key Laboratory of Tree Breeding

In depth studies of genetic diversity of *Schima superba* plus tree germplasms are particularly important for conservation, utilization resources, and the development of future breeding programs for this plants. A total of 734 *S.superba* plus tree germplasms from 24 areas of five provinces in China, were analyzed systematically with 10 SSR primer pairs. There was a high level of genetic diversity in *S.superba* plus tree germplasms, and a significant difference of genetic diversity between populations. The genetic distance of 24 populations were ranged from 0.030 to 0.804, with an average of 0.230, showed a closely genetic relationship between populations. The Shannon's information index (*I*) of populations were ranged from 0.980 to 1.431, and the genetic diversity were not completely related to geographic distribution. The results of principal coordinate analysis (PCoA) and genetic structure analysis were basically consistent, 734 varieties were divided into three groups in PCoA or five subgroups in STRUCTURE analysis. The results of genetic structure analysis indicated that 71.1% germplasms were with single genetic structure, the rest 28.9% were with mixed genetic structure. The AMOVA results showed that the differentiation among populations contributed to 5.91% of total genetic variation, and the differentiation within populations contributed 94.09% of total genetic variation. We considered not only the geographically distant, the genetic relationship between populations or individuals also should be noticed in crossbreeding parents' selection of *S.superba*.

Analysis of genetic diversity of China fig (*Ficus carica* L.) cultivars using simple sequence repeat (SSR) markers

Sun Yanxiao , Wang Xianrong
Nanjing Forestry University

The fig (*Ficus carica* Linn.) is become to be a good economic tree species in China. In this study the genetic diversity of 20 China cultivars of figs is analyzed using SSR marker previously developed. The results reveals that the 7 pairs of SSR primers used amplified a total of 25 alleles in the accessions studied. The number of alleles per locus ranged from two to five, with a mean value of 3.57 alleles per locus. Observed and expected heterozygosities showed mean values of 0.9549 and 0.6655 respectively. The results showed a high genetic diversity between 20 fig cultivars in Shandong province of China, and have no genetic communication between individuals.

Identification and expression pattern analysis of Pheromone binding proteins gene AglaPBP1 and AglaPBP2 in the Anoplophora glabripennis (Coleoptera: Cerambycidae)

Wang Jingzhen
Beijing Forestry University)

This study aims to identify the pheromone binding proteins genes of the Anoplophora glabripennis (Motsch.) and detect tissue-differential expression of two PBPs both in male and female. To identify the pheromone binding proteins genes, two PBPs genes fragment was obtained by blast based on antennal transcriptome we have established. By cloning and sequencing we obtained the complete sequences and then bioinformatic methods were also employed. Real-time PCR

were employed to detect expression pattern of PBPs gene in different sexes. Two PBPs genes were obtained from A. glabripennis and named as AglaPBP1(Gen Bank accession no.KX272639) and AglaPBP2(Gen Bank accession no.KX272640). The open reading frame in AglaPBP1 is 411bp, encoding 136 amino acid residues with the predicted molecular weight and the isoelectric point of 15.02 kDa and 4.22 respectively. The open reading frame in AglaPBP2 is 408bp, encoding 135 amino acid residues with the predicted molecular weight and the isoelectric point of 15.007kDa and 5.16 respectively. AglaPBP1 and AglaPBP2 all have signal peptide in 1-21 and 1-19. Both AglaPBP1 and AglaPBP2 were characterized by six conservative cysteine (Cys) residues. The AglaPBP1 and AglaPBP2 had about 74% and 49% identity with PBPs from Batocera horsfieldi (Hope). qPCR analysis indicated that AglaPBP1 was expressed in antennae , maxillary palp and Leg, and female antennae expression was higher than male. While, AglaPBP2 was almost specific expressed in male antennae. Clearing AglaPBP1 and AglaPBP2 expression in different parts lays a foundation of further study for function and clears the molecular mechanism of insect smell identification.

NaCl-induced changes in vacuolar H+-ATPase expression and vacuolar membrane lipid composition of two shrub willow clones differing in their response to salinity

Zhang Min, Chen Qingsheng, Zhou Peng
Jiangsu Academy of Forestry

It has been suggested that vacuolar H+-ATPase (V-H+-ATPase) plays a pivotal role in salt stress, and salt stress could modulate the expression and enzyme activity of V-H+-ATPase. In this work, salt modulation of V-H+-ATPase and tonoplast fatty acid compositions were evaluated in two shrub willow clones differing in salt tolerance after 3 , 6 and 12 days of treatment. The results showed that the activity of V-H+-ATPase was regulated tissue and clone specifically under NaCl stress. In the leaves of salt-tolerant clone 2345, treatment with 100 mmol/L NaCl increased V-H+-ATPase activity first and then decreased it at day 12, while V-H+-ATPase activity was stimulated in the roots by NaCl during the treatment time. In contrast, V-H+-ATPase activity reached the highest value at day 3 in the leaves of salt-sensitive clone 2367 and then it decreased. Western blot and immunofluorescency analysis of V-H+-ATPase subunit E revealed that the protein content varied in parallel with V-H+-ATPase activity. Moreover, a decreased unsaturated fatty acids ratio to saturated ones together with an increased V-H+-ATPase activity was detected in the roots of salt-tolerant clone 2345 at day 12. Altogether, it suggested that the induction of V-H+-ATPase expression and increase in the saturation of tonoplast fatty acids as a homeostatic mechanism for shrub willow to cope with salt stress.

Session CSF-08 (88-6): Decentralization and forest governance in Asia and Pacific region

Transforming forest property right regimes on the ground by decentralization with top-down approach? evidences from China

Liu Jinlong
Renmin University of China

Since the 1980s, decentralization has become a major feature of forest governance around the world, and China is a unique country in this respect. Forest property right regimes and how transformed in the era of globalization and marketization in the centralization and decentralization period have been investigated through comparative cases study. No single forest property right regimes can fit to all, leading to failure of implementing Collective Forest Tenure Reform on the ground. . De facto forest property right regimes to forests in China are highly complex as private owner, or the mixture array of proprietor, claimant, authorized user and owner due to the varying forms of land, types of tree and non-timber forest products that exists and has evolved over time due to political, social, economic and cultural change historically. De Jure property rights of forests have transformed greatly during in centralization and decentralization period in China, however de facto property rights of forests have not been changed on the ground. De Jure rights provided legality to claim the alienation rights of forests or one sort of products harvested from forests. mushrooms that are essential to the success of mushroom management and improvement of villagers' livelihood. The study revealed that collective forest tenure policy in practice has not reflected historical conditions and needs of local communities, and failed to be implemented on the ground at least in the selected villages.

The impacts of fiscal decentralization reforms on decentralized forest governance: case study of changting county of China

Long Hexing , Tu Chengyue , Liu Jinlong
Renmin University of China

Fiscal decentralization policy is often promoted for economic development, but its impact on decentralized forest governance in developing countries is not well understood. This paper analyzes a case study toward decentralized forest governance in the Changting County of China over the past few decades, with a special focus on influence of fiscal decentralization reforms on the incentives and behaviors of local government. In a decentralized regime, fiscal decentralization can lead to increase taxes and fees of timber and over-exploitation of natural forest when local government lacks sufficient finance revenue, but local government would shift from grabbing hand to helping hand if it gains sustainable finance transfer and effective supervision from upper levels of governments. The study indicates that fiscal decentralization and related fiscal transfers are essential if decentralized forest governance is to succeed in achieving positive ecological, economic, and social benefits.

Public innovation in forestry: can legality verification be decentralized?

Wilhelmus de Jong
Toyto University

The paper assess the shifts in public innovation of forest policies and regulations that affect the timber sector and the role played by communities in those shifts in the northern Bolivian Amazon since 2008. The analysis adopts a public innovation conceptual framework. Bolivia enacted wide-reaching land and forest reforms in the mid-1990s aimed at regularizing tenure rights and promoting sustainable forest management. While these reforms introduced significant changes regarding the previous situation characterized by extended competing claims on forests, uncontrolled logging in public lands, and exclusion of local forest users, these policy reforms still suffered from several shortcomings. Subsequent adjustments adjustments were made in response to social pressures from forest communities and chainsaw operators, supported by

social groups such as traders, and civil society organizations, in order to better accommodate the needs and requirements of local forest users who were unsatisfied with the previous reforms. The revisions have allowed the incorporation of smallholder and community practices, which were previously illegal, into legal practices. One result has been a boost in timber supply facilitated by forest communities' access to markets. The latter has increased the incomes and the distribution of incomes within communities. An important effect has also been an improvement of compliance with timber regulations, which has reduced illegality in the sector overall.

Community forestry in Nepal: from co-management to governmentality

Bijendra Basnyat[1], Thorsten Treue[2], Ridish Kumar Pokharel[3]
1. Institute of Forestry
2. University of Copenhegan
3. Tribhuvan University

This paper explores how the forest bureaucracy has regulated and subsequently centralised authority transferred to forest user groups in Nepal. Analyses of policy documents, legislation, and forestry sector programmes over the past 40 years combined with present day stakeholder interactions and a user group survey in the country's western hills show that the history of community forestry can be divided into three distinct phases: (i) the progression phase (1976-1988), which focused on devising appropriate legislative and institutional arrangements; (ii) the co-management phase (1989-2000), which focused on sharing of responsibility for forest protection and management between the forest bureaucracy and forest user groups; and (iii) the governmentality or re-centralisation phase, which began with the 2001 Forest Policy. To maintain or regain control in a different than the traditional centralised top-down manner, the forest bureaucracy has devised and enforced, officially and unofficially, several guidelines and decrees that re-establish its authority over decentralised forest resources. Some of these techniques and strategies even contradict the letter and spirit of official forest legislation, notably the 1993 Forest Act. This governmentality approach has enabled the forest bureaucracy to curtail the autonomy of forest user groups and enhance its control over forest resources and associated economic benefits.

Politics of scientification in community forestry of Nepal

Srijana Baral
Institute of Forestry

This paper explores how scientific forestry narratives are being mainstreamed in community forestry of Nepal to establish control over forest resources. The study is based on policy analysis, stakeholder consultations, review of management plans and forest inventory in nine community forests in the mid hill district. In the early years of community forestry, it had few technical requirements but integrated local knowledge and practices. However, with the amendment of the 2001 Community Forestry Guidelines, scientific forestry narratives were introduced, through forest inventory and the sustained yield principle. Later, scientification of community forestry was further strengthened by introducing more 'science' in the form of 'scientific forest management plans', especially in highly productive forest. Analysis of the 'scientific' plans and their preparation process reveals adoption of a 'scientific brand', rather than 'scientific knowledge, approaches or methods'. These plans have very limited scientific base, are improperly prepared and dilute the meaning and value of the underlying science. It appears that forest bureaucrats are using the scientific forestry narrative to create illusions that allow them to control forest user groups and resource use, rather than to achieve sustainable forest management. Hence, scientification is used to establish authority of great consequence but little scientific relevance.

International arrangement on forest - opportunities and challenges

Lang Yan
Chinese Academy of Forestry

International Arrangement on Forest (IAF) was established by the Economic and Social Council in 2000, aiming at promoting the management, conservation and sustainable development of all types of forests and to strengthen long-term political commitment to this end. Its components and partners cover UN member states, major forest related international organizations, interested regional and subregional organizations, major groups and other stakeholders, etc. In 2015, ECOSOC adopted the Resolution on the International Arrangement on Forests beyond 2015. The three aspects of the new IAF will provide an open window for countries and regional organizations seeking opportunities for Sustainable Forest Management, i.e., building a “Global Forest Financing Facilitation Network”, establishing the United Nations Strategic Plan for Forests 2017-2030, enhancing the evolvement of regional, subregional organizations and stakeholders. However the weaknesses of IAF, i.e. No legal-binding international agreement on forest, governance fragmentation, lacking of implementation still keeps the implementation of IAF initiatives facing challenges. This presentation gives an overview of IAF and its new progress, analyses the new progress and the opportunities it bring, and discusses the potential future of IAF.

Poster Presentations

Poster Presentations

Division 1

Adaptive forest management in China: climate change impacts, silvicultural options and transformations

Liu Shirong, Wang Hui, Yang Yujing
Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

The forest, as an important component of terrestrial ecosystem, plays a major role in global carbon cycle. Climate change has affected forest ecosystems in China through a long term observed changes in vegetation phenology, tree growth, species distribution, forest structure and species composition, forest productivity, and forest pest and disease outbreaks and forest fire regimes. Projections of climate change also suggest profound impacts of climate change on forest ecosystem structure and functions, jeopardizing forest mitigation potential and other ecosystem services. Since forest carbon sequestration is important and sensitive to climate change, proactive forests management strategies are imperatively needed to mitigate and adapt climate change by adopting appropriate silvicultural options and transformations to enhance the capacity of forests as carbon sink and its resilience to cope with the changing climate. Such adaptive forest management measures in China include: 1) strengthening the monitoring and assessment of forests across different geographical gradients in response to climate change; 2) selecting suitable tree species for afforestation and reforestation and transforming the existing pure forests into mixed plantations; 3) encouraging natural ecological restoration of degraded forest lands while protecting the existing natural forests; 4) improving the capacity building of forest pest/disease/fire forewarning and prevention and control ability; and 5) adjusting silvicultural regime to multiple purpose forest management. Importantly, forestry agencies at all levels should give an equal high priority to forest adaptation as forest mitigation and put concrete measures in place in order to enhance forest resilience and carbon sink capacity while reducing the likely negative impacts of climate change on forests, which is essential for sustaining multiple forest ecosystem provided for sustainable development and human wellbeing under a changing climate.

Email: liusr@caf.ac.cn

Stand origin has a significant effect on the morphology and nutrient content of lower-order fine roots in Cunninghamia lanceolata forests

Wu Chunsheng[1,1],Wei Xiaohua[2,1], Liu Yuanqiu[1,1]
1. College of Forestry, Jiangxi Agricultural University
2. Earth and Environmental Science, University of British Columbia (Okanagan)

Fine roots (diameter <2 mm) are an important component of plant roots because they absorb water and nutrients from the soil to meet the needs of plant transpiration and photosynthesis. This study aimed to understand the morphology (including diameter, specific root length (SRL), root length density (RLD) and root number per unit (RN)), biomass and changes in the carbon and nitrogen contents of fine roots of different root orders (1-5) in *Cunninghamia lanceolata* forests

(*CF*) of two different stand origins (*i.e.*, sub-tropical artificial middle-aged (age: 19 years) (*Acf*) and natural mid-succession (age: 20 years) (*Ncf*) forests). The results showed the following: The fine root diameter, SRL, RLD and RN of lower orders (grades 1, 2, and 3) and the carbon and nitrogen contents of the first stage were significantly different between *Acf* and *Ncf* but were not different in higher root orders. The diameter, SRL, RLD, RN and carbon and nitrogen contents of the lowest (1 and 2) fine root orders in *Acf* were significantly different between different soil layers, and in *Ncf,* these parameters were significantly different between different soil layers in the lowest (1, 2, and 3) fine root orders. The main changes in fine roots of *Cunninghamia lanceolata* were closely related to vegetation growth and the sensitivity of the soils of different forest types.

Email: 1013259834@qq.com

Dendrobium candidum, practice and application in sustaining agroforestry systems

Zhao Jing, Zhang Huatong, He Xujun, Liao Qingwen, Liao Jingling
Guangdong Eco-engineering Polytechnic

Exploring and applying agroforestry system is an important approach for forestry sustainable development. The 'silvo-medicinal' systems (medicinal plants growing in forests) has been a crucial practice in Asian countries, which can make full use of forestry resources and enhance rural livelihoods without destruction of the forest. *Dendrobium officinale* ranks the first among the nine Chinese herbal medicines, which plays a very significant role in health care. It's a kind of valuable plant resources in the silvo-medicinal system. Imitating wild cultivation of *Dendrobium officinale* in forests not only ensures its medical value, but also keeps forestry sustainable development. The purpose of this research is to screen out high quality wild *Dendrobium officinale* germplasmand establishan efficient imitating wild cultivation system. Wild *Dendrobium officinale* *g*ermplasms will be collected from Guangdong, Guangxi, Yunan and Fujian provinces. Their medicinal values will be evaluated by measuring polysaccharide and free amino acid, etc., and a molecular evaluating system will be established by real-time PCR. High-quality wild *Dendrobium officinale* genotypes will be screened out, and then grown in the grapefruit farm in Guangdong province to establish a high efficient imitating wild cultivation system. The *Dendrobium officinale* genotypes and the cultivation system will be deployed in the South of China.

Email: 85885652@qq.com

Effect of close-to-nature management on species diversity in a cunninghamia lanceolata plantation

Sun Dongjing, Jia Hongyan,Ming Angang
Experimental Center of Tropical Forestry, CAF

This study examines the performance of close-to-nature(CTN) transformation in a *Cunninghamia lanceolata* stand in Pingxiang, Guangxi, China. Four broad-leaved species *Castanopsis hystrix*, *Mytilaria laosensis*, *Castanopsis fissa* and *Machilus pingii* were randomly inter-planted into the *Cunninghamia lanceolata* stand after the first thinning in the 11th year. We studied the community composition, species diversity and growth status in different thinning densities under the impact of CTN management. Results showed that: five years after the CTN management, (1) the number of species in tree layer, shrub layer and herb layer were highly increased. The dominant species in shrub layer and herb layer varied before and after thinning operation. (2) The average DBH of

Cunninghamia lanceolata was significantly increased with the thinning intensities (*p*thinning density increased. Significant differences were found in the DBH and height of *Castanopsis fissa* and *Castanopsis hystrix* in different thinning intensities (*p Cunninghamia lanceolata* plantation, intolerant species such as *Castanopsis fissa* and *Mytilaria laosensis*, as well as neutral species *Castanopsis hystrix,* were suitable for inter-planted in highly thinned stands, while the shade tolerant species like *Machilus pingii* performed better in medium thinned stands.

Email: happysdj@163.com

Provision of soil protection by forest plantations: implication for management

NahiaGartzia-Bengoetxea[1],Jean-MichelCarnus[2],
IñigoUrrutikoetxea´-Álvarez[1],AnderArias-González[1]
1. NEIKER-Tecnalia
2. INRA France

Soil degradation is a serious problem in Europe and erosion is one of the major threats for it. Planted forests, when sustainably managed, have a central role preventing soil degradation. Universal Soil Loss Equation (USLE) was applied in two municipalities mainly characterized by planted forests of *Pinus radiata* in northern Spain. The region is characterized by steep slopes and frequent precipitations. USLE has been widely used for calculating annual soil losses based on rainfall, runoff, slope, runoff length, soil type and land use parameters. In this study, potential soil loss (without forest cover) was estimated and compared with erosion estimated with current forest cover categorized in 4 different stand development stages (seedlings, young thinning, advanced thinning and mature). Over 150 soil samples were taken in forest plantations and analysed to model USLE in the selected municipalities. Soil protection increases when the plantations get older mainly because of the increase of the cover factor and the higher content of soil organic matter. This results in an increase of the soil structure factor. In this work, the protection of soils and watercourses provided by plantations is highlighted and the implications for clear-cut forestry discussed.

Email: ngartzia@neiker.eus

The study on seed tree method and soil preparation technology to support natural regeneration of Siberian larch (*Larix sibirica* Ldb.) dominated forests

Barshagul Soltonbyek
National University of Mongolia

The forested area is 14320.5 thousand hectare of total area in Mongolia. Its well known that are large amount of area affected and degraded cause of natural and anthropogenic disturbances such as forest fire, insect outbreaks, illegal logging in each year. However, natural regeneration particularly by Siberian larch (Larix sibirica Ldb.) is relatively less than disturbed area in total, and tending to replace by birch and poplar species. Therefore, it’s important to support activity on natural regeneration and enlarge forested area in Mongolia. For the purpose of this study, we aimed to set different technological methodology to examine natural regeneration ability of larch dominated forests. In this study, we selected two different methods that are selective cutting method to improve light condition on understory and soil preparation method to investigate regeneration ability on different soil property. According to this research, to provide sustainable

forest management based on the technological methods to improve natural regeneration of larch dominated forests in Mongolia. As expected result of this study is to improve technological methods to support natural forest regeneration ability, it's essential for the economic and natural benefits of Mongolia.

Email: SJ.Barshonko@yahoo.com

Growth performance of several woody species planted in semi-desert regions of Mongolia

Ser-Oddamba Byambadorj[1], Batkhuu NyamOsor[1],
Khaulenbek Akhmadi[2], Janchivdorj Lunten[2], Batkhishig Ochirbat[2]
1. National University of Mongolia
2. Institute of Geography and Geoecology, Mongolian Academy of Sciences

Species selection with tolerance to drought, cold, salt and other natural and anthropogenic impacts are important for success of tree planting especially in arid and semiarid regions of Mongolia. The objectives of this research were: 1) to select appropriate irrigation norm and their effects on growth planted trees; 2) to select suitable fertilizer type and their effects on growth of planted trees; 3) to select most promising species for the successful afforestation semi-desert environments of Mongolia. Two-year-old seedlingsof four different species (*Tamarix ramosissima* L, *Ulmus pumila* L, *Elaeagnus moorcroftii* Wall, *Hippophae rhamnoides* L,) were planted in drip irrigation site with four different regimes (control, 4L hour tree^{-1},8L hour tree^{-1}, 12L hour tree^{-1}) and four different fertilizer applications (control; nitrogen-NIT; combined-NPK; compost-COMP). Seven years monitoring on growth performance shown that all measured variables (root collar diameter, height, survival rate) were significantly differed among treatments and species level. Overall survival rate of planted trees was in compost (76.6%) and nitrogen (78.6%) fertilization treatments. Whereas, *Eleaegnus* (98.1%) and *Ulmus* (96.3%) seedlings had significantly higher survival rate compared with other species, which suggesting that these native species had more adaptive characteristics compared to other species used in this study.

Email: serko_2008b@yahoo.com

Population characteristics of two distinctive saxaul stands from Mongolia

EnkhchimegTsedensodnom[1],BatkhuuNyamosor[1],KhaulenbekAkhmadi[2],
JanchivdorjLunten[2], BatkhishigOchirbat[2], Ser-OddambaByambadorj[1]
1. School of Engineering and Applied Sciences, national university of mongolia
2. Institute of Geography and Geoecology, Mongolian Academy of Sciences

Haloxylon ammodendron C.A. Mey Bunge is a desert shrub with ecological and economic importance. Because of the severe drought and excessive use of Saxaul forests, which is the only forest component in the Gobi desert area, caused loss of Saxaul forests on 125.0 thousand ha land in Mongolia. Local people settling in arid zone continue to utilize woods, shrubs and bushes for their fuel wood consumption. This is becoming a crucial factor in sand movement and sand accumulation causing desertification and land degradation. Two distinctive populations of *H. ammodendron* distributed in Eastern (Dornogobi province) and Southern (Umnugobi province) Mongolia was assessed for survivor and mortality on established 3 monitoring plots (in total 6 plots) in each site. Studied populations were dominated by juvenile and adult individuals and the natural regeneration was extremely limited except one plot in Dornogobi province. Tree size distributions were skewed towards larger size classes in two populations. The survivorship curves showed the highest mortality in the early life stages (S, J, A1 and A2) and stabilized in later stages. These results suggest that studied populations of *H. ammodendron* are threatened and efforts are required to minimize uncontrolled exploitation and overgrazing. Limited seedling recruitment requires conservation efforts in order to protect existing populations in both provinces.

Email: smileenkhii39@gmail.com

Assessment of regeneration of degraded pasture in desert steppe, Mongolia

Tsengel Batkhisihg, Tsognamsrai Damdin
National University of Mongolia

This article presents some results of experimental research conducted in Delger bag, Bayandelger soum, Sukhbaatar aimag with the objective of rehabilitating degraded pastureland between 2007-2014. The main vegetation type of the study region belongs to Dornogobi sub-province of Desert steppe. The vegetations with dominance of Cleistogenes-Stipa and Artemisia-Stipa are considered as the main distributed communities within this sub-province. Within this objective, several experiments were conducted including fencing and establishing sylvo-pasture at degraded area and associated changes and responses of selected plant community were assessed with relevant mathematical estimations. Compared to control site, species numbers were increased by 3, 0 times; and individual numbers were raised by 4, 3 times respectively at the fencing sites. In parallel, species numbers were increased by 4, 5 times; and individual numbers were raised by 5, 8 times at the sylvo-pasture site during the study period. Species richness index both of Margalef and Menhinick as well as Berger- Parker index for dominance were the highest at the sylvo-pasture site. In addition, values of β diversities measured by Whittaker's, Harrison's and Routlegde's indices on selected community were estimated at higher rate at sylvo-pasture than both fencing and control plot. Our study results show that establishing sylvo-pasture is highly effective in terms of potential impacts for supporting natural regeneration of Cleistogenes-Stipa community than fencing technique only.
Email: tsengel@seas.num.edu.mn

Growth and biomass allocation of two-year-old saxaul seedlings \ under different concentration of salt stress

BatzorigYadamsuren[1],BatkhuuNyamosor[1],
EnkhchimegTsedensodnom[2],BayasgalanDagvadorj[2]
1. National university of Mongolia
2. Institute of Geography and Geoecology, Mongolian Academy of Sciences,

Soil salinity and drought are common environmental problems affecting seed germination, seedling establishment and plant growth especially in arid and semi-arid regions. This study aims to determine the effects of salt stress on growth and biomass allocation in two-year-old of Saxual using NaCl (dominant), $MgSO_4$ and $CaCl_2$ (10:1:1) mixtures with concentration ratio of 800-10000 mg/l, electric conductivity of the solution was 1.51, 4.36, 10.4, 13.8 and 17.2 dSm^{-1}. Seeds were planted in plastic post in Gobi sandy brown soil for one year with watering of 50% of soil field capacity. After one year, seedling establishment, salt stress treatments were applied and seedling shoot height, root collar diameter and biomass allocation was assessed during the growing season of 2015. The salt stress test results show that 800-5000 mg/l treatment does not affected

seedling gwoth performance while concentration of 7500-10000 mg/l led to significant reduction of growth by limiting shoot lenght growth, meanwhile increasing lateral shoot branching which resulted increased shoot biomass accumulation. Increased salt concentration in soil limits the root growth of two-year-old seedlings which decreased root to shoot ratio of the grown seedlings. Overall, Saxaul seedlings can acclimate salinity at some levels, according to our experiments within 800-10000 mg/l in southern Mongolia.

Email: batzorigbtzo@gmail.com

Lesson learnt in combat deserttification project in Mongolia

Sebin Kim
1. Chungnam National University
2. Norheast Asian Forest Forum

The Northeast Asian Forest Forum (NEAFF) is a non-governmental organization (NGO) for the restoration and conservation of forests in the Northeast Asian regions, which is based at Seoul, Republic of Korea (ROK). The NEAFF was founded in 1998 and comprises a group of representatives from industries, environmental organizations, forester's group, academic communities, and individuals in Northeast Asian countries.

The objectives are to restore the degraded forestlands, to combat desertification and deforestation, and to promote the environmentally sound and sustainable management of forest ecosystems in the Northeast Asian regions by strengthening the networks among the countries concerned.

The international cooperation of NEAFF is directed towards rehabilitating degraded forestlands and combating desertification, developing environmental education program, and exchanging information for sustainable forest management and forest conservation in the Northeast Asian regions. Major projects include the joint project for combating desertification in Mongolia (750 ha in Selenge and 40 ha in Gobi Desert) by planting trees and sand fixation, exchanging personnel and information among the participating countries, organizing international workshops and seminars with ITTO, UNCCD, FAO and other international organizations.

This presentation shows environmental restorations that NEAFF conducted over last 10 years in Mongolia.

Email: sbkim@cnu.ac.kr

Long-term experimental plot observations of even- and uneven-aged stand growth at the University of Tokyo Forests, Japan

Toshiaki Owari, Takuya Hiroshima, Keisuke Toyama, Kazuya Oomura, Seiji Ishibashi
The University of Tokyo Forests, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan

Long-term experimental plots can provide reliable and consistent data for forest growth and yield research. The oldest experimental plots at the University of Tokyo (UTokyo) Forests, Japan, with stand description, summary statistics and key findings are presented. The UTokyo Chiba Forest

(35°8−12′ N, 140°5−10′ E) has 10 experimental plots in even-aged *Cryptomeria japonica* and *Chamaecyparis obtusa* plantations planted between 1900−1905, of which 9 plots were established in 1916. The plot size is 0.02−0.54 ha. The UTokyo Chichibu Forest (35°53−57′ N, 138°46′−139°00′ E) holds 32 experimental plots in *C. japonica*, *C. obtusa*, *Chamaecyparis pisifera*, and *Larix kaempferi* plantations planted between 1913−1955. The plots were installed between 1934−1970 with the plot size of 0.04−0.34 ha. In each plot, the diameter at breast height (dbh) for all trees and the height for sample trees have been measured every 5 years. The UTokyo Hokkaido Forest (43°10−20′ N, 142°18−40′ E) has 68 experimental plots in uneven-aged stands managed under selection system, of which 35 plots were established between 1929−1966. The plot size is 0.20−1.00 ha. The dbh for all trees with dbh ≥ 5.0 cm have been measured in each plot at 5-year intervals. Newly recruited trees that reached the minimal dbh, harvested trees, and trees died during the measurement intervals have been recorded consecutively.

Email: owari@uf.a.u-tokyo.ac.jp

Growth performance of several woody species planted in dry-steppe regions of Mongolia

SerOddambaByambadorj[1],NandingerelDaramragchaa[1],BatkhuuNyamosor[1], KhaulenbekAkhmadi[2], JanchivdorjLunten[2], BatkhishigOchirbat[2]
1. National University of Mongolia
2. Institute of Geography and Geoecology, Mongolian Academy of Sciences

Mongolia is one of the countries which has serious problem with desertification and land degradation. Numerous activities for rehabilitation had been conducted but most of them showed poor results due to harsh climate, lack of understanding of the ecological characteristics of planted trees. The objectives of this research were: 1) to determine effects of different irrigation on the growth of trees; 2) selection certain fertilizer and their effects on growth on trees; 3) selection of promising species for dry steppe of Mongolia. Two-year-old **s**eedlingsof *Populus sibirica* Tausch, *Tamarix ramosissima* L, *Ulmus pumila* L, *Elaeagnus moorcroftii* Wall, *Hippophae rhamnoides* L was grown under four different watering regime (control, 2L hour tree^{-1},4L hour tree^{-1}, 8L hour tree^{-1}) and two fertilizer regimes (control; combined-NPK; compost-COMP). Five years of monitoring reveled that all measured variables (root collar diameter, height, survival rate) were significantly differed among treatments and species. Good performance was observed in trees grown at 8L hour tree^{-1} treatment and COMP treatment in all species. In terms of species level *Populus* (306 cm) and *Ulmus* (208 cm) had shown good growth performance. In case of survival rate, *Populus* (97.6%) shown higher survival rate and lowest survival rate was observed in *Tamarix* (11.7%).

Email: serko_2008b@yahoo.com

Effects of irrigation and soil type on the growth and biomass accumulation in two-year-old saxaul seedlings

Ser-OddambaByambadorj[1],BatkhuuNyam-Osor[1],ZoljargalSainbuyan[1],BatzorigYadamsuren[1],Khaulenbek Akhmadi[2],JanchivdorjLunten[2],BatkhishigOchirbat[2]
1. National University of Mongolia
2. Institute of Geography and Geoecology, Mongolian Academy of Sciences

The main aims of this study were development of agrotechnology for breeding of containerized seedlings of Saxaul (*Haloxylon ammodendron* C.A. MEY. Bunge) for restoration of Saxaul forests in desert region of Mongolia with following objectives: 1) selection of suitable irrigation regime and 2) selection of suitable soil type for production of containerized seedlings. The study was conducted under research framework of Korea-Mongolia Joint “Green Belt” Plantation Project. Seedlings were grown in vinyl containers using three different soil types under three different irrigation regimes followed by soil field capacity. According to results of different treatments of soil type and irrigation, growth performance of seedlings grown in Gobi sandy brown soil was superior compared with other treatments. In terms of irrigation regimes, treatment of 50% of soil field capacity showed positive effect on seedling growth and biomass. According to above results containerized seedlings can be grown in Gobi sandy brown soils with irrigation of 50% of soil field capacity. Root development monitoring results showed that Saxaul seedlings had intensive root growth than shoot growth. Researches on physiology, especially on water use efficiency and gas exchange should be completed in future for successful restoration and conservation of Saxaul forests in the region.

Email: serko_2008b@yahoo.com

Assessing ecological impacts of exclosures as landscape rehabilitation measures in Northern Ethiopia

Emiru Birhane Hizikias[1,2], Tefera Mengistu[3], Yigremachew Seyoum[3], Nigusie Hagazi[4], Alemayehu Berehe[1], Zefere Mulaw[5], Nuru Mohammed[5], Habtemariam Kassa[6]
1. Mekelle University (MU)
2. Norwegian University of Life Sciences (NMBU)
3. Ministry of Environment, Forest and Climate Change (MEFCC)
4. World Agroforestry Center (ICRAF)
5. Wondogenet College of Forestry and Natural Resources
6. Center for International Forestry Reserach

Establishing exclosures (EXs) has been used as a major mechanism to reduce land degradation, conserve moisture and restore degraded agricultural and forestlands in Ethiopia. But knowledge about its ecological impacts remains limited. We identified better managed AEs from three altitudinal ranges, and investigated their ecological contribution by examining 18 sites. Open grazing lands (OGL) adjacent to EXs were used as control sites. Vegetation and 419 soil samples were collected from 210 nested rectangular plots of 10m x 20m on parallel laid systematic line plot. A total of 224 soil samples to a depth of 12 cm were collected for soil seed bank analysis.Biomass estimation for all woody plants was done using a verified allometric equation while GHLs biomass was determined destructively. Species composition, species diversities, regeneration status, densities, species richness and SSB density were significantly higher in EXs compared to OGLs ($P<0.05$). The conversion of OGLs to EXs led to significant increment in total biomass, vegetation carbon and soil carbon stock ($P<0.05$), indicating improved ecosystem services. EXs showed a significant increment in carbon sequestration ($P<0.05$). The net present value of EXs carbon trading potential was estimated at 282% (US$ 345.5/ha), higher than OGLs (US$ 122.23/ha), showing higher capacity to generate revenue and to mitigate climate change. We conclude that EXs as a land rehabilitation strategy resulted in positive ecological impacts on formerly degraded OGLs. The study also provided a strong evidence to scale up EXs as a forest land restoration instrument in the dry lowlands and degraded highlands.

Email: emiru.birhane@mu.edu.et

A novel spatially explicit model for sparse forest pattern based on digital terrain data

Wu Yin [1, 2], Zhang Jing [1], Yao Xueling [2], Guo Binbin [1], Wang Feng [2]

1. Beijing Key Laboratory of Resource Environment and Geographic Information System, Capital Normal University, Beijing 100048, China

2. Institute of Desertification Studies, Chinese Academy of Forestry, Beijing 100091, China

Clarification of the coupled mechanisms that determine the spatial pattern of vegetation in semiarid ecosystem remains a challenge in ecology and bio-geoscience. Current studies have shown that the spatial pattern of vegetation is both a cause and effect of variation in resource availability in semiarid ecosystem. Moreover, resource heterogeneity is often caused by small-scale topographic variation. In this study, we propose a spatially explicit model for sparse forest pattern to examine the impact of small-scale topographic variation on the trees distribution on sandy land in semi-arid area. We develop a new method to classify local terrain into ridge, shady slope, sunny slope, sandy plains and sandy lowland by using high-resolution digital elevation model (DEM) data acquired by Unmanned Aerial Vehicles(UAV). The spatial distribution of trees are modeled as a 2-D Poisson process with rate of the mean number of trees per unit area in the same type of terrain. Trees are represented as circles of random radius, which are drawn from an exponential distribution with mean values of diameter at breast height in the same type of terrain. Our model is applied to elm (Ulmus pumila) sparse forest on Otindag sandy land located in Inner Mongolia, Northeast China. We find that the highest density of elm trees is located on the shady slope and the lowest density is located on the sandy lowland across different type of terrain (Fig. 1a). Furthermore, the close agreement between observed spatial pattern of elm trees and the simulated ones shows that the spatial pattern of elm sparse forest was strongly associated with local terrain in this area (Fig. 1b). Finally, the model can help us understand the impact of topography on spatial pattern of vegetation on the sparse forest ecosystem in semiarid area.

Email: wangfeng@caf.ac.cn

Effects of dynamic processes of wind erosion on sand particle distribution on the stoss slope of migratory dunes in the Mu Us Desert, China

Bao Yanfeng [1],Hao Yuguang [3], Xin Zhiming [3],Zhao Yuanyuan [2], Gao Guanglei [2], Xu Jun [3], Gao Junliang [3], Gegenbatu[3], Wang Xuequan [1], Ding Guodong [2]

1. Insitute of Desertification Studies , Chinese Academy of Forestry, Beijing, China

2 . College of Soil & Water Conservation, Beijing Forestry University, Beijing, China

3. The Desert Forest Experimental Center, CAF, Dengkou, China

Understanding the effects of wind erosion dynamics on sand particle size distribution (PSD) provides important information for combating desertification in the Mu Us Desert of China. We found that different wind velocities tended to converge and accelerate from the toe towards the crest of the dune's stoss slope. The soil particles were mainly composed of fine sand particles. There was a correlation between the content of fine sand and the dynamics of the migratory dune. The variation in PSD was closely related to the wind velocity, as it varied from the toe to the crest of the dune. The PSD data indicated that the motion of sand flux at the surface changed from creep to leap with an increase in wind flux. Sand particles were coarser at or near the crest under high wind velocities. The PSD was fairly uniform at different sites on the slope, with well1 and moderately well1sorted sizes, symmetrical skewedness, and mesokurtic kurtosis. Variation in the D value (volume1based fractal dimensions) was mainly caused by the accumulation of fine

sand at each site. Variation in the content of fine sand revealed the saturation state of the sand flux and whether the motion of sand particles was creeping or leaping, as well as the development of the dune's tendency to gradually migrate.

Wind tunnel simulation for the wind velocity flow field of photovoltaic panel

Sun Tao[1,2], Liu Shizeng[1], Ji Yongfu[1], Xu Xianying[1], Zhang Yinghua[1], Tang Jingnian[1,2]
1. *Gansu Desert Control Research Institute State Key laboratory of Desertification and Aeolian Sand Disaster Combating Lanzhou 730070，China*
2. Institute of Desertification Studies, Chinese Academy of forestry，Beijing 100091，China

The Photovoltaic panel (PV) models were installed in the wind tunnel, with the angles between the panel and wind direction of β=45° and β=90°， the variation of flow field under different wind velocity, 5 m/s，8 m/s，12 m/s，16 m/s was studied. It aims to find out the effect of different angles on wind velocity flow field. The result shows: under different wind velocities, 3 areas as the front of the panel, the middle of the panel and the rear of the panel were formed, and 4 speed-reduction areas and 3 wind-acceleration areas were also formed. With different angles, the wind velocities of the panels are different. The comparison between the treatments of β=45° and β=90° showed for the former one, there's longer distance of wind reduction, which has accelerated the consumption of wind energy; when the wind passes the middle of the PV, the wind velocity fluctuation on the upper vortex is rather small in the case of β=45°, while the wind velocity rises quickly in the case of β=90°. In the rear of the panel, the average wind velocity in the case of β=45° tends to reduce more slowly comparing with the case of β=90°. Viewing the overall wind velocity variation, the panel of β=45° is stronger in resisting wind erosion than the panel of β=90°, which can effectively reduce the destruction caused by up-lifting and undercutting when the wind passes the middle of the panel, then it can effectively avoid the destruction to the panels caused upon by wind. The study will offer reference for the large-area installation of the PV panels in the desert areas.

Email：suntaosuny@163.com

Associated analysis of soil properties and shrubs growth characteristics in Alpine Sandy of Qinghai Province, China

Li Shaohua[1], Zhang Liheng[1,2], Chen Xinjun[1], Wang Xuequan[1], Gao Qi[3]
1. Institute of Desertification Studies, Chinese Academy of Forestry, Beijing 100091, China;
2. Gansu Desert Control Research Institute, Lanzhou 730000, China;
3. College of Grassland, Resources and Environmental, Inner Mongolia Agriculture University, Hohhot 010019, China

To maintain plantation sustainable management and provide the basis ecological safety in the Alpine sandy. The shrub land (sand dunes-Caragana and interdune sandy-Salix) at different growth years in Shazhuyu sand experimental forest farm were studied. Through standard wood investigation, collecting soil samples and laboratory experiments, analysis of the artificial restoration 3, 12, 21, 30, 42 and 51 years of vegetation growth characteristics, shrub zone soil physical and chemical properties of which indexes correlation. The results shows: (1)With Caragana and Salix growth 51 years, plant height, crown width, ground diameter and new shoot biomass changed significantly($P<0.05$), compared with the 3 year shrub, which were increased by 11.1, 41.4, 18.1 and 4.3, 8.8, 18.5 multiple respectively. 30 years Caragana and 21 years Salix

averaged new shoot biomass reached the maximum, was 100.79 g and 81.33 g respectively. (2)Compared with comparison plots, the average change rate of the Salix and Caragana plots soil depth 10, 30, 50 and 70 cm at moisture content which reduced 17.6%, 47.9%, 60.9%, 39.7% and 8.2%, 44.5%, 47.8%, 39.8%, the surface soil clay content of 51year Salix and Caragana increased 251.2% and 140.2% respectively($P<0.05$), soil capillary moisture capacity increased 119.9% and 35.0% respectively($P<0.05$), soil bulk density reduced 21.9% and 20.3% respectively ($P>0.05$). 3, 12, 21, 30, 42, 51 years Caragana and Salix topsoil organic matter content was 0.94, 1.02, 1.51, 2.48, 3.93, 5.35 multiple and 1.05, 1.76, 2.90, 3.74, 4.31, 4.53 multiple than comparison plots. (3)Correlation analysis showed that clay content-capillary water, clay content-soil organic content and clay content-crown width had a very significant positive correlation, were 0.788, 0.769, 0.843 and 0.816, 0.747, 0.852 respectively, Soil water content-crown width had a very significant negative correlation, was reach -0.892 and -0.796 respectively. (4)Sand-fixing shrub growth characteristics and plots soil properties achieved the optimal relatively at 21 ~ 30 years recovery, in order to achieve forestry sustainable development in Alpine sand land, it had better to take promptly tending management measures.

Study of forest landscape restoration at site and landscape scale in Changbai Mountains

Zhao Fuqiang, Qi Lin, Dai Limin, Yu Dapao
Key Laboratory of Forest Ecology and Management, Institute of Applied Ecology, Chinese Academy of Sciences

Forest landscape restoration is becoming an increasingly important objective of forest management. The objective of the study was to explore how to restore reasonable landscape-scale forest structure in Changbai Mountains. We combined field survey, ArcGIS mapping and R language data analysis to answer how to restore the forest structure at landscape scale. At site scale, we quantified seed dispersal and natural regeneration mechanism, and establish natural regeneration ability class of major tree species. At landscape scale, we extracted site conditions data from DEM and the forest survey date of study area. Potential development forest type of each land type was established through filed survey at primary forest and literature summary. Combined with landscape integrity and diversity, the suitable development forest types at landscape scale were determined. By comparing the forest composition of potential development forest types and existed forest, the location and the species for regeneration were determined. Finally, based on the nature regeneration ability of major tree species, we can set the restoration method of each forest unite (natural regeneration or artificial regeneration). A forest landscape restoration technology of Changbai Mountains was established.

Email: Zhaofuqiang@iae.ac.cn

The quality assessment of long term topsoil stockpiles of sandy soil in gobi desert, Mongolia

Uuganbayar Buyantogtokh[1], Batkhishig Ochirbat[2], Batchuluun Tseveen[1]
1. National University of Mongolia
2. Institute of Geography, Mongolian Academy of Science

Topsoil stripping and preservation and its quality management is an important aspect for the rehabilitation in future. Oyu Tolgoi (OT) gold-copper mining is located in Khanbogd Soum, Umnugobi Aimag, which is 640 km south of the capital city of Mongolia; Ulaanbaatar. Currently there are 1,623,348.51 cubic meter topsoil that has been stored in 8 long-term topsoil stockpiles at the mine site. The purpose of the topsoil quality monitoring is to determine the soil quality of current topsoil stockpiles in comparison with the control sites as well as the pre-disturbance soil assessment of the land. The soil samples were taken from the long term topsoil stockpiles to check its physical, chemical and biological properties. Soil organic matter and macronutrients were within the range of control site. The organic matter was less than 1% in all stockpiles which is common in Gobi Light Brown soil in Mongolia. The electrical conductivity (EC) ranges 0.69-3.2dS/m and calcium carbonate ($CaCO_3$) 3.7-8.36% respectively. All the topsoil stockpiles were sandy and sandy loam texture which was similar with the control sites and the pre-disturbance assessment report. Overall the topsoil stockpile quality was not deteriorated over the storage time and could support the plant growth when using the rehabilitation.

Email: uuganbayarbuy@ot.mn

Division 2

Genetic variation of growth and stem straightness in second generation Tectona grandis in Sri Lanka

Bandara Ariyaratna Kangane Mudiyanselage
Forest Department

Tectona grandis is one of the main industrial plantation tree species in Sri Lanka. The seed improvement of this species was started in early 1970s by establishing clonal seed orchards in the dry and intermediate areas of the country. Even though, clonal seed orchard establishment was commenced in 1970s systematic genetic improvement was initiated in 2007 with the establishment of second generation progeny trial. The progeny trial comprised 250 families of plus trees selected in Sri Lanka; 225 families from plantations and 25 families from clonal seed orchards. This trial was planted in a row-column design with 6 replications, and five tree row-plots. Survival and growth data (DBH and height) measurements were taken at 8 years after planting. The stem straightness of the trees was assessed at 5 point scale (entire height or more than stem straight- 5; of the stem straight- 4; of the stem is straight-3; less than of the stem- 2; not straight- 1).Significant differences were observed among seed sources and families within seed sources for DBH, tree height, individual tree volume and stem straightness. The heritability estimates for the growth and stem straightness were low and comparable with other tree species. Further, the genetic correlation between growth and stem straightness was also low indicating that the selections for the timber volume will not adversely affect on stem straightness. The results suggest that considerable genetic gain in growth traits is possible using the Sri Lankan teak breeding population.

Email: abandara15@hotmail.com

Phenotypic and physiological response to chilling stress in seedlings of three Pinus caribaea varieties

Hu Jiwen[1,2], Dai Ying[1,2], Li Zhen[1,2], Zhao Fencheng[1], Huang Shaowei[2], Guo Wenbing[1]
1. Guangdong Academy of Forestry
2. South China Agricultural University

A pot trial was established with 17 provenances from three varieties of *P. caribaea* (PCC, PCB and PCH) and 4 provenances from *P. elliottii* (PEE) to evaluate their genotypic variations in cold hardiness. The phenotypes were recorded and the growth were measured through the winter. The secondary needles were sampling when the temperature dropped down to 5℃, and the concentrations of thesoluble sugar, the reactive oxygen species(ROS), the magnesium proto-porphyrin (Mg-Proto), as well as the activities of phenylalanine ammonialyase (PAL) were investigated. The needles suffering chilling injury showed diverse symptoms in different varieties and became purple in some PCC, PCB individuals and PEE, while the needles spotted with yellow in PCH. Significant variations were found among the varieties and provenances in all the indices, except for ROS which were highly individual. The concentrationof Mg-Proto were lower in PCC, PCB and PEE provenances/individuals showed symptoms, in which the chlorophyll biosynthesis might be inhibited. The soluble sugar and PAL accumulation were significantly lower in PCH than the other varieties and PEE. The regulation patterns of the four indices implied that the lack in responses to low temperature might be the mechanism of the poor cold hardiness in PCH.

Email: hujiwen020@126.com

Root iTRAQ protein profile analysis related to phosphorus efficiency in two Pinus elliottii × P. caribaea Clones

Dai Ying[1,2], Li Zhen[1,2], Hu Jiwen[1,2], Zhao Fencheng[1], Huang Shaowei[2], Guo Wenbing[1]
1. Guangdong Academy of Forestry
2. South China Agricultural University

Previous studies indicated that the growth of *Pinus elliottii* × *P. caribaea* depends on P efficiency and is related to root traits. To identify key metabolic pathways related to P-efficiency by proteomics approach, we screened the candidate proteins involved in low P stress adaptation in P-efficient clone (H4) and P-inefficient clone (M31) under normal and low P treatments (HP and LP). Proteins were extracted from the roots of cutting seedlings and were analyzed using isobaric tags for relative and absolute quantification (iTRAQ).

The results revealed that the expression of identified proteins were affected by both genotypes and treatments, including some phosphate starvation-induced proteins reported previously such as purple acid phosphatase and phosphate transporters. In total, 704 and 719 differentially expressed proteins (DEPs) were detected between P treatments in H4 and M31, respectively. Only 325 DEPs were overlapping in the two clones, indicating the genotypic variations in responsive strategies to low P. Interestingly, 351 DEPs between treatments in H4 also showed genotypic difference under LP, which might play crucial roles in P efficiency in *Pinus*. KEGG analysis of above DEPs implied that citric acid cycle metabolic pathway,pentose phosphate pathway and pyruvate metabolism pathway might be involved.

Email: mdaiying@126.com

Genoytypic evaluation for phosphorus efficiency In *Pinus elliottii* × *P. caribaea* clones in hydroponic culture

Li Zhen[1,2], Hu Jiwen[1,2], Dai Ying[1,2], Zhao Fencheng[1], Lin Dongjiao[2], Guo Wenbing[1*]

1. Guangdong Academy of Forestry
2. South China Agricultural University

Phosphorus plays an important role in the growth of the hybrid pines. The study was carried out in hydroponic culture treated with 0mM P (LP) or 1mM P (HP) with six clones of *Pinus elliottii* × *P. caribaea*. The experimental designs were split-plot designs with ten replications. After six months, a comprehensive evaluation had been made on the six clones of the *Pinus elliottii* × *P. caribaea*, according to the performance of height increment, ground diameter, biomass and root traits. Combined with the height increment, ground diameter and biomass, we chose two P-efficient clones (H1、H2) and one P-inefficient clone (L1). It was found that the phosphorus treatments, and genotypes had significant effects on those indices by analysis of variance. The interaction between genotypes and treatments also had a significant effect on the height increment and biomass. The plants performing well under both LP and HP conditions were P-efficient genotypes. Under LP condition, the height increment, total dry weight of the P-efficient were higher than the P-inefficient by 96% to 104%, 32% to 78%. The total root length and root surface areas were 42% to 56%, 16% to 23% higher than the P-inefficient. The changes of root traits might be the adaption mechanisms of the hybrid pines to low P stress.

Email: lizhenlz@stu.scau.edu.cn

Cadmium influx, allocation, and detoxification in poplars overexpressed bacterial γ-glutamylcysteine synthetase

Luo Zhibin[1], He Jiali[2]
1. State Key Laboratory of Tree Genetics and Breeding, Research Institute of Forestry, Chinese Academy of Forestry, Beijing 100091, China
2. College of Life Sciences and State Key Laboratory of Crop Stress Biology in Arid Areas, Northwest A&F University, Yangling, Shaanxi, 712100, P. R. China

Overexpression of bacterial γ-glutamylcysteine synthetase in the cytosol of *Populus tremula* × *P. alba* produces higher glutathione (GSH) concentrations in leaves, thereby indicating the potential for cadmium (Cd) phytoremediation. However, the net Cd^{2+} influx in association with H^+/Ca^{2+}, Cd tolerance, and the underlying molecular and physiological mechanisms are uncharacterized in these poplars. We assessed net Cd^{2+} influx, Cd tolerance, and transcriptional regulation of several genes involved in Cd^{2+} transport and detoxification in wild-type and transgenic poplars. Poplars exhibited highest net Cd^{2+} influxes into roots at pH 5.5 and 0.1 mM Ca^{2+}. Transgenics had higher Cd^{2+} uptake rates and elevated transcript levels of several genes involved in Cd^{2+} transport and detoxification compared with wild-type poplars. Transgenics exhibited greater Cd accumulation in the aerial parts than wild-type plants in response to Cd^{2+} exposure. Moreover, transgenic poplars had lower concentrations of $O_2^{\bullet-}$ and H_2O_2; higher concentrations of total thiols, GSH, and oxidized GSH in roots and/or leaves; and stimulated foliar GSH reductase activity compared with wild-type plants. These results indicate that transgenics are more tolerant of 100 µM Cd^{2+} than wild-type plants, probably due to the GSH-mediated induction of the transcription of genes involved in Cd^{2+} transport and detoxification.

Email: luozbbill@163.com

Study on somatic embryogenesis in *Larix principis-rupprechtii* Mayr and *Pinus tabulaeformis* Carrière

Zhao Jian[1], Li Hui[1], Li Dan[2], Zhang Jinfeng[1]
1. Beijing Forestry University
2. Southwest Forestry University,Yunnan Academy of Biodiversity

Somatic embryogenesis (SE) is one of the most important methods for plant regeneration in plant cell engineering, which has great application value on large scale vegetative propagation, artificial seed production, germplasm conservation, and genetic transformation, and has a wider application prospect for forest trees with long life cycles, such as conifers. From another aspect, SE is widely recognized because it is the pattern system to study the mechanism of embryogenesis. *Larix principis-rupprechtii* Mayr and *Pinus tabulaeformis* Carrière are two main afforestation species in Northern China, while their productions and researches are severely affected by ineffective propagation and breeding technologies. In this study, various stages of cones of *L. principis-rupprechtii* and *P. tabulaeformis* are collected for stage characterization and element determination, through which we can adjust medium component to optimize these two SE systems. SE system of *P. tabulaeformis* was established successfully for the first time and SE system of *L. principis-rupprechtii* was optimized effectively. For further understanding, we develop transcriptomics and proteomics study on embryogenic callus (EC), non-embryogenic callus and somatic embryos in various stages. By using bioinformatics analysis, some potential key genes and proteins are identified. In the SE of *P. tabulaeformis*, 25 differentially expressed genes are embryo development related, including genes encoding late embryogenesis abundant (LEA) protein, somatic embryogenesis receptor-like kinase (SERK), embryonic flower 1 (EMF1), etc. During SE in *L. principis-rupprechtii*, 92 differentially abundant proteins are identified, which are mainly related to metabolic process, signal transduction, protein biosynthesis, storage proteins, antioxidation, cytoskeleton organization, transporter, binding and so on. The present study lay a foundation for large-scale vegetative propagation and further genetic improvement of *L.principis-rupprechtii* and *P. tabulaeformis*, and provide theoretical guidance for the application of somatic embryogenesis technology into forestry production with revealing the essence of somatic embryogenesis from transcriptome and proteome level.

Email: zhaojian0703@bjfu.edu.cn

Use of DNA barcodes for species identification of CITES-protected Dalbergia wood

Jiao Lichao[1], Yin Yafang[1], Alex C. Wiedenhoeft[2]
1. Chinese Research Institute of Wood Industry, Chinese Academy of Forestry
2. Center for Wood Anatomy Research, Forest Products Laboratory, Forest Service of Department of Agriculture

With the sharp increase of global forest resources trade and deforestation, *Dalbergia* wood species has rapidly become a focus of attention for conservation, including additional listings of species in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in recent years. To assist in controlling trade, accurately identifying wood at the species level is an essential component in the protection of endangered and precious *Dalbergia* wood. However, species-level identification is often difficult or even impossible for traditional wood identification methods. One such technique is with potential to make species-level identification is DNA barcoding of wood. In this study, three CITES-listed wood species, *Dalbergia retusa* Hemsl.,*Dalbergia tucurensis* Donn. Sm. and *Dalbergia cochinchinensis*Pierre, were selected for species identification via DNA barcoding technology. Our results indicated that DNA fragments of

300-500 bps could be successfully retrieved from wood tissues using a modified Qiagen kit protocol, especially for heartwood. Moreover, the suitable DNA regions were selected as DNA markers for separating and identifying the *Dalbergia* wood species. DNA barcoding has great potential to support law enforcement efforts to curb illegal logging of *Dalbergia*, and thus help conserve endangered and valuable wood species.

Email: jiaolichao@126.com

Effects fertilization on the chlorophyll content and leaf morphological characteristics in several woody species in Mongolia

Batkhuu Nyamosor[1], Oyuntugs Altantugs[1], Enkhchimeg Tsedensodnom[2], Ser-Oddamba Byambadorj[1]
1. National University of Mongolia
2. Institute of Geography and Geoecology, Mongolian Academy of Sciences

This main objectives of this research was determine the effects of fertilization on the leaf chlorophyll content and leaf morphological characteristics in several woody plants in dry steppe and Gobi desert region of Mongolia. Six different species (*Ulmus pumila* L., *Caragana microphylla* Lam., *Elaeagnus moorcroftii* L., *Armenica sibirica* Lam., *Hippophae rhamnoides* L., *Populus sibirica*) which are planted in four different fertilization treatments including control, nitrogen-NIT, combined-NPK and compost-COMP were employed in this study. According rsearch results fertilizers had a significant effects on measured variables *H. rhamnoides*, *E. Moorcroftii* compared with other species. Generally, leaf area decrease significantly correlated with total leaf biomass and fertilizer application, especially nitrogen containing fertilizer induced the increase of total chlorophyll content. Specific leaf area is one of the criteria to assess the thickness of the leaves, which is correlated with chlorophyll content of leaf per area; similar results were found in our research in *C. microphylla, E. moorcroftii* and *H. rhamnoides*. Among four different fertilizers nitrogen (NIT) treatment in Dalanzadgad soum (Gobi desert), compost (COMP) treatment in Lun soum (dry steppe) had more intensive effects on chlorophyll content and leaf morphological characteristics.

Email: nbatkhuu@gmail.com

Leaf water potential and stomata characteristics under different irrigation regimes in some trees planted in dry regions of Mongolia

Batkhuu Nyamosor[1], Zoljargal Sainbuyan[1], Enkhchimeg Tsedensodnom[2], Ser-Oddamba Byambadorj[1]
1. National University of Mongolia
2. Institute of Geography and Geoecology, Mongolian Academy of Sciences

Mongolia is one of the countries which has serious problem with desertification and land degradation. Thus, numerous activities for rehabilitation had been conducted but most of them showed poor results due to harsh climate, and lack of understanding of the ecology and biology of trees. The objective of this research was to measuring leaf water potential and stomata characteristics in some woody species, including *Ulmus pumila* L., *Populus sibirica*, *Hippophae rhamnoides* L., under different irrigation regimes (control, 2L hour tree^{-1}, 4L hour tree^{-1}, 8L hour tree^{-1} and 12L hour tree^{-1}) in Lun soum (dry steppe) and Dalanzadgad soum (Gobi desert).

According diurnal measurements we could conclude that measured trees in both sites had more stressed by water deficit between 12:00-18:00 (-3.3±0.06MPa~-0.7±0.02MPa), especially midday at 14:00 pm with lowest leaf water potential of -1.65±0.2MPa. In case of seasonal measurements, lowest leaf water potential measured in August with minimum value of -3.3±0.06MPa. Non-stop 32-hour measurement of leaf water potential in Lun soum (day steppe) showed that trees are not affected by water deficit between 22:00-04:00 am (-0.4±0.1MPa). Stomata characteristics (open, half-closed, closed stoma) of measured trees tend to have more closed stomata between 08:00am -18:00 pm and it can be confirmed by measurement of leaf water potential.

Email: nbatkhuu@gmail.com

Effect of future climate change on seed sourcing of Platycladus orientalis a widespread and important reforestation conifer in China

Mao Jianfeng
National Engineering Laboratory for Tree Breeding, College of Biological Sciences and Technology, Beijing Forestry University

As important component of forest resource management, seed zone and seed transfer guidelines are significantly crucial to ensure that seedlings are well adapted to the growing conditions of planting site. *Platycladusorientalis* is one of the most widespread conifer in China, and is extensively used in ecological restoration projects in the arid mountain landscapes of northern China. This tree has distinct characteristics such as strong adaptability, cold-resistant, disease resistance, drought-resistant in thin soil. A system of seed zone delimitation was developed through provenance trials in 1980s and widely used following on. However, climate change accelerate a problem that seed is well matched under current climate will be growing in sub-optimal conditions in the future. Therefore, it’s important to provide a sense of the magnitude of seed zone changes. Here, we predicted the suitable range shifts for each seed zone under four future climate scenarios (RCP2.6, RCP4.5, RCP6.0, RCP8.5) in 2050 and 2070 generated by Coupled Model Intercomparison Project 5 (CMIP5), the Intergovernmental Panel on Climate Change (IPCC). Ecological niche modeling perform better than random and provide detailed prediction of the areal changes, the spatial shifts, and the migration path of each seed zone under the different future climate scenarios. The suitable habitat of each seed zone expands across all future climate scenarios/years, but the change rate is different among the five seed zones. Prediction show that more than 90% of the areas in each seed zone remained unchanged; the retraction rates of suitable habitat are all under 9%, with an average of 1%; the gains rate of suitable habitat are all around 10%, except the southern seed zone with a 75% gain rate. With the intensity of greenhouse gases increasing (from RCP2.6 to RCP8.5), we see a general trend of increasing in suitable habitat expansion even the increasing rates are different. When we compared the areal change of different seed zones under the same future climate scenarios/years, we see a general increase pattern in the suitable habitats for all seed zones with the south seed zone displaying a more remarkable gain in suitable habitats. It is also predicted the suitable habitats will shift northward in latitude and upward in elevation under future climate scenarios and the distance traveled for each seed zone is different, but the movement direction is mostly identical. This study provide a sense of the magnitude of seed zone changes, and a new reference geographic mapping of seed sourcing. The results will provid an important point of reference for seed transfer, afforestation and ecological restoration, it would also greatly contribute to the establishment of forest management adaptation strategies intended to mitigate the negative impacts of climate change.

Email: jianfeng.mao@bjfu.edu.cn

Growth and physiological responses of Abies koreana to elevated temperatures

Sun HeeKim,Sun MiJe,Kyong HaKim,Joo HanSung
National Institute of Forest Science

Temperature play an important role in plant growth and physiological responses, thus it is a major determining factor in the distribution of plants across different environments. *Abieskoreana* is representative species which is known to be a vulnerable to the climate change in South Korea. The purpose of this research is to investigate the effect of elevated temperature on growth and physiological responses in 3-year-old seedlings of *A*. *koreana.* We exposed *A*. *koreana* to different air temperatures (amb., amb.+2℃, amb.+5℃) using the temperature gradient chamber system(TGC). At 3 months after temperature treatment, tree height and root growth diameter significant decreases with the increasing temperature. Also, gas exchange responses (photosynthetic rate), light harvesting ability (maximum quantum yield of PSΠ photochemistry and total chlorophyll contents), and carbon fixation ability (carbon efficiency and maximum carboxylation rate) were decreased by increasing temperatures. We conclude that elevated temperature during 3 months could bring out the decrease of growth and physiological activities of *A*. *koreana*. And further work is required to fully understand a mechanism to adapt to elevated temperature during long-term.

Email: sands02@korea.kr

Seasonality of carbon flow in a pine tree estimated using in situ 13C pulse-labeling method

Satoru Takanshi[1], Masako Dannoura[2], Takashi Nakano[3], Yuji Kominami[1], Takafumi Miyama[1]
1. Forestry and Forest Products Research Institute
2. Kyoto University
3. Mount Fuji Research Institute, Yamanashi

In recent years, forests are expected as carbon reservoir for the future climate changes and Net Ecosystem Exchange (NEE) has been measured by the eddy covariance method at many forests. To understand the carbon sequestration of a forest, we need to know processes of carbon flows and stocks in a forest. The process of carbon flow in a tree is important role to estimate carbon budget of forests, but still unclear. To understand carbon flows in a tree, we carried out in situ ^{13}C pulse-labeling experiments for a mature pine tree (Pinus densiflora, Tree height: 20m) at a cool-temperate coniferous forest site (AsiaFlux site code: FJY). The experiments were carried out September 2012, December 2012, and July 2013, covering the canopy of the tree by a plastic film chamber and introducing 13CO2 into the labeling chamber. Carbon effluxes from a trunk surface were monitored by the Tunable Diode Laser Spectrometer (TDLS). The carbon flow speeds ranged from 0.04 to 0.24 m/hr and relatively slow in winter. The amount of carbon respired from the trunk surface were ranged 14-20% of the assimilated carbon.

Email: kominy@ffpri.affrc.go.jp

Seed quality traits of two distinctive saxaul (Haloxylon ammodendron) populations of Mongolia

Batkhuu Nyamosor[1],Narantugs Dulamsuren[1],Enkhchimeg Tsedensodnom[2],Ser-Oddamba Byambadorj[1],Tsagaantsooj Nanzaddorj[2],Wuyunga Bold[1]
1. National University of Mongolia
2. Institute of Geography and Geoecology, Mongolian Academy of Sciences

Mongolia is one of the countries severely affected by desertification and land degradation. *Haloxylon ammodendron* is an important component of the desert ecosystem which distributed in 3825922 ha in the south of Mongolia and is one of the main shrub species used for ecological restoration. We compared the seed quality traits of two distinctive populations of *H. ammodendron* from eastern and southern Mongolia, namely, Dornogobi and Umnugobi provinces. Seeds were collected in 2015 from three different plots (in total 80 mother trees) and after seeds are cleaned they were classified into three different seed sizes (small, medium and large) using soil sieves with three mesh sizes (1.0mm; 1.4mm and 1.6mm). Seed quality traits, 1000-seed weight, germination energy (GE), germination percent (GP) was assessed. The mean 1000-seed weight of two populations was 3.5 gr in Dornogobi and 2.8 gr for Umnugobi province. The results show that the seeds from Umnugobi province (GE 84.4±1.2%) had best performance compared with Dornogobi (GE 63.5±1.5%) in all assessed traits. In terms of seed size, large seeds tend to have more high germination capacities compared to small and medium sized seeds. This study provides a reference for the selection of high-quality *H. ammodendron* seeds for drylands of Southern Mongolia.

Email: nbatkhuu@gmail.com

Genetic variation patterns in a diversity experiment with aspen

Zhang Chunxia
Northwest A&F University

Poplars are model tree species in ecological and genetic studies due to their wide distribution, easy propagation and abundant genetic and genomic resources. A poplar diversity experiment has been established with European and North American aspen (*Populus tremula*, *P. tremuloides*) planted in plots representing either a single population only or combinations of two, four and eight populations in order to test the influence of intraspecific diversity on ecosystem functions and services. In this study, simple sequence repeats (SSRs) and amplified fragment length polymorphisms (AFLPs) were used to analyze the genetic diversity and differentiation within and among populations and to estimate the genetic diversity within each plot of this experiment. Large differences regarding the genetic diversity within populations were observed. The genetic diversity estimates based on both markers showed a high correlation. An analysis of molecular variance revealed that most of the total genetic diversity was found within populations, but the genetic differentiation among populations was also high. As expected, the *P. tremuloides* population was strongly differentiated from the *P. tremula* populations. The complex patterns of genetic diversity and differentiation resulted in large differences of the genetic variation within plots. The average diversity increased from plots with only one population to plots with two, four and eight populations, respectively. However, the genetic variation within plots strongly depended on the specific mixture of population, and the highest diversities among all plots in current diversity experiment were observed for plots with only two populations mixed. We conclude that the number of populations included within a plot is a poor predictor of its diversity. The high and variable levels of genetic diversity observed within all populations need to be considered in

assessments of the impact of intraspecific diversity of poplars on the diversity of associated organisms and ecosystem functions and services.

Email: czhang@nwsuaf.edu.cn

Responses of leaf functional traits and photosynthetic physiological indices of castanopsis fargesii, castanopsis sclerophylla and cyclobalanopsis glauca seedling leaves to warming and nitrogen addition under artificial control conditions

Zhao Guangdong[1], Wang Zhiyuan[2], Shi Zuomin[1], Wang Bing[1]

1. Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry, Beijing 100091, China

2. Tongzhou Landscape and Forester Bureau, Beijing, 101101, China

Through MSR-2420 infrared radiation warming devices and nitrogen fertilizer addition, warming and different nitrogen fertilizer application level(0 、60 、120 kg · hm^{-2} · a^{-1}) was set up to investigate the effects of the warming(W), nitrogen fertilizer(N1 and N2）and their interaction(WN1, WN2) on specific leaf area, leaf nitrogen content per unit mass, leaf nitrogen content per unit area, leaf dry matter content and photosynthetic physiological indices of *Castanopsis fargesii*,*Castanopsis sclerophylla* and *Cyclobalanopsis glauca* seedings, the dominant species of evergreen broad-leaved forest in the mid-subtropical zone. The results showed that: (1) during January 2012 to January 2013, the mean air temperature, the mean soil temperature at the depth of 5 cm and 20 cm were enhanced by 1.22 ℃, 1.05 ℃ and 0.65 ℃, however the mean air relative humidity, the mean soil volume water content at the depth of5 cmand20 cmwere 7.07%, 7.02% and 5.52% lower than that in the control area. (2)In the condition of warming, the leaf dry matter content was higher than that of the control area while the specific leaf area and leaf nitrogen content per unit mass were opposite. (3)The nitrogen addition led to the increase of leaf nitrogen content per unit mass、leaf nitrogen content per unit area and leaf dry matter content and the decrease of specific leaf area. (3)The specific leaf area, leaf nitrogen content per unit mass, leaf nitrogen content per unit area and leaf dry matter content responses of *C.fargesii*, *C.sclerophylla* and *C.glauca* to warming and nitrogen interaction were different.The independent effect of warming and nitrogen on the specific leaf area of *C.fargesii* was lower than that of their interactions, and the interactions on the specific leaf area of *C.sclerophylla* were similar to the independent nitrogen, but there was no significant effects on the specific leaf area of *C.glauca*. The response of three seedlings leaf leaf nitrogen content per unit massto warming and nitrogen was basically consistent irrespective of the effects of their independent and interactive. The independent and interactive effects of warming and nitrogen to the leaf nitrogen content per unit area of *C.sclerophylla* were similar. The effects of warming and nitrogen interaction to leaf nitrogen content per unit area of *C.fargesii* was higher than that of the independent nitrogen, furthermore the effect of WN1 was lower than that of WN2. The corresponding results of *C.glauca* were as follows:warming and nitrogen interaction effects were lower than the independent nitrogen and the effect of WN2 was higher than that of WN1. The interaction of warming and nitrogen caused the leaf dry matter content increment of three seedling leaves.(4) Warming caused the decrease of Chl a, Ch b, Chla+Chl b, soluble protein and soluble sugar content while the Chl a/Chlb and the content of starch were increased; (5) Under the condition of nitrogen fertilizer addition, the increase of Chl a, Chl b, Chla+Chl b content and the decrease of soluble sugar and starch content were significant. The soluble protein content of *Castanopsisfargesii* and *Castanopsissclerophylla* seedling leaves increased while *Cyclobalanopsisglauca* seedling leaves showed the reverse changing trend. (6) The interactive effects of warming and nitrogen addition on photosynthetic physiological indices of three seedlings were consistent with nitrogen fertilizer

addition. There were somewhat differences between WN1 and WN2among different tree species. In a word, warming caused the decrease of *Castanopsis fargesii* and *Castanopsis sclerophylla* seedling leave chlorophyll content and restrained the accumulation of plant photosynthetic metabolite accumulation, and nitrogen addition promoted the protein synthesis and increased the consumption of soluble sugars. The photosynthetic physiological responses of the three tree species to the interaction of warming and nitrogen addition were almost consistent with the separate nitrogen addition.

Email: zhaogd@caf.ac.cn

Genetic diversity of casuarina equisetifolia

Hu Pan[1], Zhong Chonglu[1], Zhang Yong[1], Jiang Qingbin[1], Chen Yu[1], Chen Zhen[1], Khongsak Pinyopusarerk[2], Didier Bogusz[3], Claudine Franche[3]

1. Research Institute of Tropical Forestry, Chinese Academy of Forestry, Guangzhou 510520, China

2. CSIRO National Research Collections Australia, Acton, ACT 2600, Australia

3. Equipe Rhizogénèse, UMR DIAPC, IRD (Institut de Recherche pour le Développement), 34394 Montpellier Cedex 5, France

Casuarina equisetifolia ssp. *equisetifolia*, nitrogen fixation trees, natural distributed in subtropical and tropical coastal areas from northern Queensland and Northern Territory in Australia, throughout southern Thailand, Malaysia, Indonesia, the Philippines, Melanesia, Polynesia and Guam, etc. The EST-SSR markers were used for to determine the genetic diversity and population structure among the 29 typical natural and introduced populations, to offer basic information for germplasm collection, protection, selection, and genetic improvement and breeding project. Based on the 34,752 EST sequences of casuarina trees in the NCBI website untill April, 2015, the 367 SSR loci can be identified from the 12,063 UniGene, distributed in the 353 EST sequences, only 2.93% frequency contained SSR loci. The 13 pairs of EST-SSR primers with amplified stability, clear band and higher polymorphism were obtained and used for genetic diversity analysis. The 308 alleles can be identified from the 13 SSR loci, average alleles number per loci was 23.69, range of alleles number was from 11 to 48. Range of effective alleles number, Shannon's index, observed heterozygosity and effective heterozygosity were 1.533 - 7.029, 0.691 - 2.139, 0.270 - 0.655 and 0.393 - 0.858, respectively. According Shannon's index, the order of genetic diversity level from high to low of the 5 regions was: African introducted (AF) > Asia natural (AN) > Oceania natural (OP) > Central American introducted (CI) > Asia introducted (AI)； the order of genetic diversity level of the 29 populations was given. The results implied that serious inbreeding between populations were occurred during the whole distribution. The main variation of *C. equisetifolia* populations were from the individuals within populations, which accounting for 70.12% of total variance. On regions level, the order of variance was: AN (81.15%) > AI (74.58%) > CI (72.29%) > AF (68.43%) > OP (61.45%). Results showed that family selection among population should be the focus of breeding. Meanwhile, though variation from populations accounted for only 25.42 % to 38.49% of the total variation, given the serious inbreeding that identified in the population, population selection should also attach great importance in future. Based on UPGMA dendrogram of 29 populations of *C. equisetifolia* using Nei's unbiased genetic distance, proved that introduced populations of China should be from Asia natural populations, while introduced populations of Kenya, and India and Veitnam might from Oceania natural populations.

Email: zclritf@21cn.com

Genetic parameters of growth and adaptive traits in aspen (*Populus tremuloides*): correlated responses of multiple traits in breeding and adaptation

Ding Chen
University of Alberta

Aspen (*Populus tremuloides*) is a widespread forest tree of economic importance in western Canada and has been the focus of tree improvement programs over the past two decades to increase the productivity and adaptation in the Canadian forests. Successful selection and breeding rely on accurate estimates of both the genetic gain for commercial traits and correlated responses of other traits that are essential to fitness. Here, to evaluate the genetic effect for tree improvement of growth traits in juvenile trees, we estimate genetic parameters of growth and adaptive traits in ten progeny trials containing more than 30,000 trees with pedigree structure based on a partial factorial mating design that includes 60 half-sib families, 100 full-sib families and 1,400 clones. Narrow-sense as well as broad-sense heritabilities were low with values around 0.2. Moderate to strong genetic correlations were found between growth and phenology (r=-0.3 and 0.7) with tall trees being associated with early budbreak and late leaf abscission. The extending use of growing season was positively linked to survival. We conclude that strong additive genetic correlations between growth and phenology indicate the genetic gain at the early stage of stand development is due to expanding the growing season.

Email: cd2@ualberta.ca

Prioritizing strategies to increase private forests participation in Korean Forest Carbon Offset program

Seunguk Shin, Yeo-Chang Youn
Seoul National University

Since Korean Forest Carbon Offset (FCO) program was introduced in 2013, there has been growing awareness on forest's role as carbon sink. However, challenges are remaining in increasing the number and scale of FCO projects needed to activate the forest carbon credit market. Especially, the role of private forest landowners, possessing about 68% of Korea's forest lands, is critical to vitalize the FCO program. To prioritize a series of policy strategies, analytic hierarchy process (AHP) was employed to weight each policy alternative according to its relative significance for the policy goal. Four?policy objectives, eight policy strategies and 20?alternatives were derived from literature review and classified as Level 1, Level 2, and Level 3, respectively. Under the main goal "increase private forests' participation?in FCO," effectiveness, efficiency, feasibility, and political acceptability were used as criteria to evaluate each alternative. The results of?survey on 18 experts in the field?indicate that they weighed the most?enforcement of private forests' competitiveness in Level 1, building capacity of forest landowners in Level 2, and?increasing collaborative management in Level 3. Understanding the priority of policy strategies to encourage private forest landowners to participate in Korean FCO is essential to set a policy roadmap to?enrich the carbon credit market, leading to contribution to achieving national target for emission reduction.

Email: ssu5337@gmail.com

Division 3

Prioritizing strategies to increase private forests participation in Korean Forest Carbon Offset program

Seunguk Shin, Yeo-Chang Youn
Seoul National University

Since Korean Forest Carbon Offset (FCO) program was introduced in 2013, there has been growing awareness on forest's role as carbon sink. However, challenges are remaining in increasing the number and scale of FCO projects needed to activate the forest carbon credit market. Especially, the role of private forest landowners, possessing about 68% of Korea's forest lands, is critical to vitalize the FCO program. To prioritize a series of policy strategies, analytic hierarchy process (AHP) was employed to weight each policy alternative according to its relative significance for the policy goal. Four?policy objectives, eight policy strategies and 20?alternatives were derived from literature review and classified as Level 1, Level 2, and Level 3, respectively. Under the main goal "increase private forests' participation?in FCO," effectiveness, efficiency, feasibility, and political acceptability were used as criteria to evaluate each alternative. The results of?survey on 18 experts in the field?indicate that they weighed the most?enforcement of private forests' competitiveness in Level 1, building capacity of forest landowners in Level 2, and?increasing collaborative management in Level 3. Understanding the priority of policy strategies to encourage private forest landowners to participate in Korean FCO is essential to set a policy roadmap to enrich the carbon credit market, leading to contribution to achieving national target for emission reduction.

Email: ssu5337@gmail.com

Design of multi-functional forest management type at scale of forest farm management unit

Liu Xianzhao, Lu Yuanchang, Hong Lingxia
Research Institute of Forest Resource Information Techniques, Chinese Academy of Forestry

A scientific design of forest development type is the premise for multi-functional forest management. How to design a multi-functional forest management type with economic value, ecological service, landscape recreation etc. play a role on economical, societal, ecological and cultural is become one of the core issues whether multi-functional forest management success or not. Base on the design example of forest management type in FuPo experimental forest farm, experimental center of tropical forestry, Pingxiang, Guangxi Zhuang Autonomous Region, our study shows the principle, method and technology of forest development type (FDT) design in a management unit under the guide of sustainable multi-functional goal. We take target function types, altitude range, soil condition and parent rock as the core index, combine the "forest nature types", "forest management objectives types" and "forest ecological function types" of *Pinus massoniana* and *Cunninghamia Lanceolata* plantation and develop a method assigning different FDTs to special sub-compartment through the "Minimum distance method" and VBA development environment. 3 FDTs of *Pinus massoniana* and 2 FDTs of *Cunninghamia Lanceolata* in this management unit combining their specific silvicultural operation, functional zone and soil condition was designed and assigned to 602 sub-compartment in FuPo experimental forest farm. Multi-functional sustainable forest management is a complicated system of long-term process, forest management plans and operation ways are always different according to different natural

condition and silvicultural objective. The forest management system which combining the “forest nature types”, “forest management objectives types”, “forest ecological function types” and silvicultural operation of long-term process, considering the main function and natural characteristics, provide a new idea and method for future forest management. The 5 FDTS of *Pinus massoniana* and *Cunninghamia Lanceolata* plantation as well as their corresponding management models were assigned to each sub-compartment which could offer theoretical foundation and technical support for forest management plan and close-to-natural forest management.

Email: lxz9179@163.com

Division 4

Design and construction of a camera prototype for tree’s phenology monitoring in a cloud forest in Colombia

Manuel Rodriguez Susa, Raquel Romero Puentes, Stephanie Cortés
Universidad de los Andes

Cloud forests (CF) are important ecosystems that support high biodiversity and offer a variety of ecosystem services to society. CF form part of the Tropical Andes Hotspot, and are vulnerable to climate change. Despite of their biodiversity and provision of ecosystem services, they are poorly studied. Monitoring trees’ phenology in CF is important to understand the behavior of flowering, fructification, fruits maturation, among others. A long-term phenology study allows not only to observe the alterations in tree phenology due to the climate change, but also their adaptative responses. We designed and constructed a camera prototype in order to monitor trees’ phenology in a CF in Eastern Cordillera (Colombia), for a long period of time. With this camera we can take consecutive pictures for a region of interest in the forest. Then, the trees’ phenology can be quantified through color change in the images. Comparing the constructed prototype with other experiments that measure phenology using cameras, ours presents advantages such as lower cost, modular structure, and lower energy consume. With the ongoing research we are taking data in CF, the prototype will be accompanied with a weather station and also with data collected from permanent plots.

Email: manuel-r@uniandes.edu.co

Analysis on growth trend of Mongolian forest for sustainability

Bayarbaatar Soronzonbold
National University of Mongolia

This study aimed to study growth trends of stands and annual increment in different age group of larch tree (*Larix sibirica* Ldb.) dominated natural mountain forests of western Mongolia. For the purpose of this study, we collected total 190 core samples in 27 sites and analyzed increment growth of each core. The average annual increment is 0.59±0.29 mm in last 400 years in this region. Yet, growth analysis by hundred years shows steady increasing trend, 0.28 mm in 1590-1714, 0.36 mm in 1714-1814, 0.56 mm in 1814-1914, 0.71 mm in 1914-2014. The radial growth of all samples showed positive relation to the temperature, while it has negative relation to the forest density (R^2=0.70) and slope *(R^2=0.63)*. Based on this result we suggest to improve current local forest management which mostly focused on protecting these forests on steep slopes. Since growth of the young stand 6-14.9 cm DBH showed negative correlation to forest density, the forest management should direct reducing density of young stand to maintain sustainability.

Email: googbayaraa@gmail.com

Sketching vulnerabilities of coastal land based resources of Bangladesh quantifying future sea level rise

Mohammed Al-Amin
University of Chittagong

Venerated for its immense contributions to the country's economy and for its readily available natural resources, the coastal zone of Bangladesh is an area whose destruction via sea level rises (SLR) would be devastating. The IPCC forecasts that global warming will result in SLR of between 0.18 and 0.79 meters.. This research is focusing on sea level rise analyzing the previous 19 years Bangladesh Inland Water Transport Authority (BIWTA) tidal data of the four eastern stations were incorporated to determine the tidal variation trends in this study. Again, the NASA Shuttle Radar Topographic Mission digital elevation model (DEM) data was used to estimate coastal vulnerability to future inundation. The alarming rising trend (14mmyr^{-1}) of mean tidal level in the river Karnaphuli reflects a high vulnerability of the South-East coastlines of Bangladesh to SLR and local factors like land subsidence. These results may recommend steps needed to be adopt and mitigate adverse consequences of flora and fauna management and show a clear sunbeam to the nation. This research is generic in nature and can be applied to any part of the world with analogous conditions.

Email: prof.alamin@yahoo.com

Spatio-temporal analyses and modelling of forest cover dynamics in Middle Povozhje

Eldar Kurbanov
Volga State University of Technology

Study of the causes and the scale of forest disturbances at regional and global levels is critical when developing solutions for effective forest management. This is especially true for forests of the Middle Volga region of the Russian Federation, which in recent decades have been subjected to severe fire, drought, led to their diebacks, windfalls and windbreaks. The purpose of the study is spatio-temporal analysis of forest cover dynamics in the Middle Volga region, based on retrospective assessment of satellite images of medium spatial resolution.

The research object is a large part of the Republic of Mari El and Chuvashia (Russia) territory with the area of over 3 million hectares. Age and spatial structure of forest stands within the evaluated area is represented by different types of vegetation, including boreal zone forest and zone of coniferous and small-leaved forests. The northern part of the research object is almost entirely represented by forested area, while almost half of the southern part area has a pronounced spatial patchiness of forest ecosystems.

Over the 30-year period the dynamics of vegetation changes (disturbance) is significantly influenced by both biotic and anthropogenic factors. Historically recurring in extremely dry seasons with an approximately equal time intervals wildfires especially stand out. Anthropogenic impact is represented by forestry activities in the form of clear cut areas, mainly in mature and over mature coniferous forest stands. Spatio-temporal dynamics were determined by analysis of a time series multi-temporal Landsat images of 30-year period. For a detailed assessment of spatial interactions multifactorial regression analysis was conducted using ArcGIS. The spatial structure of wildfires is represented by data of more than 80-years period.

Thematic maps of forest cover dynamics were developed using strata from satellite scenes of researched territory for 1985-2015 years. Thematic maps showing the disturbance of forest cover in 30 years was formed. Regularities of distribution of areas disturbed by clear cuts, forest fires of 2010 and other disturbances of the forest cover were investigated. Spatio-temporal analysis of forest cover was carried out, also taking into account the impact of its disturbance parameters (cuttings, fires).

Email: kurbanovea@volgatech.net

Spatial analysis massoia (*Cryptocarya massoia* (Oken) Kosterm.) distribution in Papua

Jarot Pandu Panji Asmoro
FORDIA

Cryptocarya massoia (Oken) Kosterm (massoia) has high economic value to the local community and generate income for the country. However, the information of species massoia is still very limited on term of distribution, real potency per hectare in natural forest, density and species richness and its ecological condition. It has been recognized that demand on massoia oil is increasing that put this species in the risk due to over exploitation in the unsustainable way. Clear cutting system has been applied by local community that would have a negative impact on massoia population. It is necessary to be able to identify the occurrence of massoia based on their position and the environmental factors. I can be done through performing spatial analysis where GIS data, remote sensing imagery, position from above sea level and soil type. The result shows massoia occurred on 44,402 Ha of Papua island which is only 1.07% of the land. This means massoia occurs in small portion of the land. This information is useful for potential area of exploration for logging company, conservation planning and massoia plantation development. Conservation and plantation might solve over exploration problem and maintain massoia production in sustainable way.

Email: pandumail@gmail.com

Land cover classification of rapideye imagery using random forest

Huang Qingfeng
School of Forestry & Landscape Architecture, Anhui Agricultural University

Random forest is a powerful machine learning classifier. Compared to the decision tree algorithm, it has much stronger generalization ability and with higher accuracy of classification. In this paper, two townships of Shitai County are taken as study area, using Rapideye high resolution imagery as the data source. Using geostatistics method to extract texture features and using Band Math to extract vegetation index. Applying random forest to selecting features by calculate feature importance value, and do the experiments to find out change trend of accuracy of classification when change the number of trees, features combination and compared to maximum likelihood method, to see which method can yield higher accuracy. The results show that: the generalized error of random forest tent to stable when the number of random forest trees (N) over a fixed value. In other words, it will not increase with the increase of N while the efficiency of computation will decrease; applying random forest and maximum likelihood classification to evaluate adding texture features yield Kappa coefficients 0.7134 and 0.6315, higher than adding vegetation indices and the combination of texture and vegetation indices. Applied random forest can yield higher accuracy than applying maximum likelihood classification. The comprehensive performance of the random forest is much better, not only can ensure the precision of the classification, but also to ensure the efficiency of operations. It is more suitable for actual production application and easy to operate.

Email: huangqf@ahau.edu.cn

Characteristics of dead organic matter pools in forest ecosystems of Jiangxi Province, China

Liu Yuanqiu, Huang Guoxian, Li Xiaodong, Liu Liangying, Wu Chunsheng
College of Forestry, Jiangxi Agricultural University

Carbon pools in forest ecosystems include the above-ground biomass, below-ground biomass, dead organic matter and soil organic matter. However, the carbon stocks of soil, litter and deadwood are merged into dead organic matter (DOM) within the Operational-Scale Carbon Budget Model of the Canadian Forest Sector Model (CBM-CFS3). The DOM are an important part in forest carbon cycle and also the focus points of climate and land use/cover change. Therefore, the study used the seventh forest resource inventory data in small classes of Jiangxi Province and the supplementary survey rules of forest resources in 2013, partitioning the soil into four grades by the fertility, and six large forest areas according to the 12th five-year plan of Jiangxi forestry development, to investigate the carbon storage characteristics of DOM in Jiangxi forest ecosystem based on CBM-CFS3. The results showed that: 1) the mean carbon density of DOM was 230.67 $t \cdot hm^{-2}$, and the largest carbon density was 249.70 $t \cdot hm^{-2}$ in western and central region among six large forest areas while the smallest was 209.17 $t \cdot hm^{-2}$ in the northern Poyang Lake Plain of Jiangxi Province; 2) the total carbon storage of DOM was 1907.10 Tg C, accounting for 79.44 % of the province's forest ecosystem carbon stocks, and the largest carbon storage of DOM was 611.63 Tg C in the southern mountainous area while the smallest was 185.75 Tg C in the eastern and central region among the six large forest areas; 3) the total carbon storage of DOM showed gradually increasing trend from the north to south across the Jiangxi, and increased with the increasing soil fertility.

Email: liuyq404@163.com

Use of infrared thermal imaging to diagnose health of Ammopiptanthus mongolicus in northwestern China

Yuan Weijie
Forestry Experiment Center of North China,Chinese Academy of Forestry (CAF)

Population of the rare and endangered species *Ammopiptanthus mongolicus* (Maxim.) Cheng f. declined rapidly in Chinas arid region and Central Asia. There is an urgent need to protect this species, which is particularly important in maintaining biodiversity throughout the arid region of northwestern China. By analyzing the infrared thermal images based onplant-transpiration transfer coefficient (h_{at}) and photosynthetic parameters, we made quantitative and accurate diagnoses of the plant growth and health status of *A. mongolicus*. Using an LI-COR6400 photosynthesis system, we measured the net photosynthetic rate *(P*$_n$), stomatal conductance (G_s), and transpiration rate (T_r). Infrared thermal images obtained in the field were processed by ENVI4.8 software to calculate surface temperatures of the plant subjects. We found that the plant transpiration transfer coefficient of *A. mongolicus* was in the order of old plants > young plants > intermediate-aged plants. Declining health levels of young, intermediate, and old plants were divided into three categories: < 0.4, 0.4–0.7, and > 0.7. The coefficient showed a significant negative correlation with T_r, G_s, and P_n, indicating that they can simultaneously reflect the state of plant growth. By establishing h_{at} and photosynthetic parameters in regression model Y = a-blnx, we can accurately diagnose plant growth and decline of plant health conditions.

Email: yuanweijie717@163.com

An improvement of the Ts-NDVI space drought monitoring method and its applications in the Mongolian Plateau with MODIS, 2000-2012

Cao Xiaoming
Chinese Academy of Forestry

Surface soil moisture is a key variable to describe water and energy exchanges at the surface/atmosphere interface and measure drought and aridification. The Ts-NDVI space is an effective method to monitor regional surface soil moisture status. Due to the disturbance of multiple factors, the established dry or wet boundary with mono-temporal remote sensing data is unstable. This paper developed a Ts-NDVI triangle space with MODIS NDVI dataset to monitor soil moisture in the Mongolian Plateau in 2000-2012. Based on the temperature vegetation dryness index (TVDI), the spatio-temporal variations of drought were studied. The results indicated that, 1) the general Ts-NDVI space method is an effective way to monitor regional soil moisture. However, if the single time space shows perfect structure, there would be no differences between the inverted results of the single time space and the general space; 2) The TVDI calculated in the paper is expected to show the water deficit for the region from low (bare soil) to high (full vegetation cover) NDVI values, and it is found to be in close negative agreement with precipitation and soil moisture, changes in the TVDI are dependent on the water status in the study area. 3) In the Mongolian Plateau, TVDI presented a zonal distribution with changes in Land Use/Land Cover types, vegetation cover and latitude. Drought was serious in bare land, construction land and grassland. Drought was widely spread throughout the Mongolian Plateau, and there was aridification in the study period. Vegetation degradation, overgrazing, and climate warming could be considered as the main reasons.

Email: caoxm@caf.ac.cn

The gravel coverage and size of Gobi desert analyzed by a rapid image-based method

Mu Yue[1], Wang Feng[1], Zheng Bangyou[2], Feng Yiming[1]
1. Institute of Desertification Studies, Chinese Academy of Forestry
2. CSIRO Agriculture, Queensland Bioscience Precinct

The Gobi desert is one of the most widespread landscapes in northwest China. The coverage and morphological characteristics of gravels on the Gobi desert are often used to understand the evolution process of Gobi desert. However, some traditional methods e.g. eye estimating and sieving, can't accurately measure these indices and is time-consuming. Here we develop a new method to accurately, promptly and automatically analyze the gravels characteristics of Gobi desert from orthoimages using decision tree model, watershed segmentation and hierarchical analysis. The main results list here including: 1) The nearer to the source region of deposits, the larger gravel coverage is. Gravel coverage increased 16% as elevation increased 1000 m along the alluvial fan. 2) Fine gravel content increased with the decrease of elevation. The average of gravel diameter is 13 mm at 820 m of elevation and 17 mm at 1840 m of elevation. Comparing the gravel morphological characteristics calculated by proposed method with manual digitization of images, the calculation time of the proposed method is 60 times faster and the calculated indices have a good agreement. Therefore, the proposed method provides a fast and precise approach to quantify the gravel morphological characteristics of Gobi desert and explore the source region of deposits and the transport/deposition process in the formation and evolution of Gobi desert.

Email: gfjiyue@163.com

Biomass and carbon storage in different types of shelterbelt in the Gonghe basin of Tibet Plateau

Liu Yanshu, Jia Zhiqing
Chinese Academy of Forestry

The purpose of this study is to compare and evaluate the biomass and carbon storage of the different types of shelterbelts in the Gonghe basin of Tibet Plateau, with the dune slacks and sand dune as control. The results indicated that *Caragana intermedia* and *C. Korshinsh* have more biomass and carbon storage, compare with *Artemisia ordosica*, among the shelterbelt that planted on moving sand dune. Compared with natural *Lyemus secalinus* grassland, the mixed forest of *Salix psammophila* has highest biomass and carbon storage, where the mixed *S. Cheilophila* has higher biomass and carbon storage than those in the pure forest of *S. Cheilophila*. All shelterbelts have significant effects on characteristics of under forest layer grassland. The shelterbelt with higher forest layer biomass and carbon storage has less grass community biomass and density. The community biomass and carbon storage that include forest and grass has the same trend among different shelterbelts. Our results clearly showed that Caragana species is the better carbon storage shelterbelt on moving sand dune, while the mixed forest of *Salix psammophila* is the best carbon storage shelterbelt the dune slacks.

Email: liuyanshu@caf.ac.cn

A review and reflection of evaluation to the benefits of forest resources

Li Zhongkui, Cheng Shaozhi, Zhang Decheng,Zhao Xiaodi
Chinese Academy of Forestry

Entered at the beginning of this century, as the problem of global ecological environment is paid more attention increasingly, the market economy is developed , the valuation of forest benefit had been changed greatly in both object and technical methods,it is thought that forest benefit should include physical output and ecological environmental effects, not only the output of timber and forest products could be quantified in value, but also the benefits such as soil and water conservation, and windbreak and sand-fixation by forest could also be valued in quantification, especially, study of the social benefit of forest is going towards quantification.
However, due to the great differences in concept and purpose , the theory and method to evaluate forest resources benefit is troubled, i.e., the benefit evaluation index is uneven, the concept of monitoring and evaluation is not distinct, evaluation object is partial and the results are not accepted. In order to develop and perfect the benefits evaluation theory and method of forest, it is raised to return the object of evaluation from monitoring index to the index of final benefit, and to make correction of the index system and method for evaluation.

Email: lzk274526@126.com

Broad-scale mapping of vertical forest stand structure across Alberta, Canada's forested landscapes using LiDAR dataset

Guo Xuan[1],NicholasCoops[1],PiotrTompalski[1],ChristopherBater[2],ScottNielsen[3]
1. University of British Columbia
2. Alberta Agriculture and Forestry
3. University of Alberta

Vegetation structure is identified as an important biodiversity indicator providing physical environment that generates, drives and maintains forest biodiversity. Light Detection and Ranging (LiDAR) remote sensing technologies has the capacity to accurately measure three-dimensional vegetation structure and has been widely used in wildlife habitat mapping and species distribution modeling. However, a structural inventory over large area describing habitat structure using LiDAR-derived variables has rarely been done. This paper applied cluster analysis on six LiDAR height-related variables to classify vegetation structure in the forested area across ten natural sub-regions in boreal and foothill forest in the province of Alberta, Canada. Eight structure classes have been identified based on canopy height distribution, variation and canopy cover. The tallest structure class is mostly abundant in Central Mixedwood natural sub-region and the most complex forest stands are commonly found in Lower Foothills natural sub-region. Human and natural disturbance have different impacts upon eight structure classes with wildfire as the most prevalent disturbance regime among all structure classes except the rarest class which was heavily altered by timber harvesting. This structure inventory layer used together with land cover classification and other complementary information will be very valuable in provincial forest resources planning, wildlife habitat monitoring, species distribution modeling and prioritization of conservation efforts on critical habitat structures.

Email: ariaguo.ubc@gmail.com

Burn probability assessment for Daxinganling under four climate scenarios

Tian Xiaorui, Miao Qinglin
The Research Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

The assessment for forest combustion is base of fire management. To simulate the fire regime under different climate change scenarios with the burn probability model is an important way to understand the effects of climate change on fire activities. The paper simulated daily fire occurrence and spread in the Daxinganling in 1971 - 2050 for four climate scenarios with the climate model data, fire weather index system and combustion probability model (BURN-P3). It was analyzed for the burn probability and fire behavior. The results showed that: BURN-P3 model can be used in the study area for simulating fire regimes. Compared with the baseline period (1971-2000), the average combustion probability in 2021-2050 under climate scenarios RCP2.6, RCP4.5, RCP6.0, and RCP8.5 would increase -6.21%, 7.71%, 7.80%, and 19.48%, respectively. The increased areas mainly distributed in the central and southern parts. Fire intensity would increase -13.0%, 4.4%, 1.5%, and 8.0% respectively. Meanwhile, the crown fraction burned would have an increase by -12.7%, 4.2%, 5.0%, and 4.7%, respectively. The central and western parts would show an increase significantly. The simulation results of BURN-P3 can reflect the status of forest burn probability in Daxinganling. Compared to the baseline period (1971-2000), the average combustion probability in 2021-2050 under climate scenario RCP 2.6 would decrease, but it would increase under RCP4.5, RCP6.0 and RCP8.5. The average fire intensity, rate of spread and combustion probability would show an increase slightly. The fire regime in central and western parts would show an increase significantly.

Email: tianxr@caf.ac.cn

Rebuilting the model on the estimation of *Pinus densata's* biomass in Shangri-la City based on Landsat TM Time-series images

Zhang Jialong
Southwest Forestry University

The TM images of Shangri-La City in 2006, forest resource inventory data in 2006 and field survey data were adopted as the data source in this paper. Sampling points were created randomly. Then, datasets were built through extracting subcompartment's mean values based onremote sensing indexes. 123 sampling points were selected by eliminating the abnormal values, and 14 indexes were collected as the alternative variables through correlation analysis. Finally, a nolinear model and a linear model for estimating *Pinus densata's* biomass were established. The model precision and prediction accuracy was alsoevaluated. The results showed that the linear model precision (Radj=0.406, RMSE=34.18 $t \cdot hm^{-2}$, rRMSE=38.54%) was better than the nolinear(Radj=0.286, RMSE=37.79 $t \cdot hm^{-2}$, rRMSE=42.60%), and prediction accuracy of the linear model (RMSE'=35.12 $t \cdot hm^{-2}$, rRMSE'=39.59%), calculated using cross-validation method, was higher than the nolinear(RMSE'=38.44 $t \cdot hm^{-2}$, rRMSE'=43.34%). Comparing with other two similar research, this model precision is slightly lower than the other two, but the the modeling data soure is much more random and resonable, the extrating indexes has also been improved. The model would provide reference for other research using remote sensing images to estimate forest biomass of typical arbor in high elevation region. At the same time, it would provide relatively complete technical methods to estimate forest biomass for the larger terrain area.

Email: jialongzhang@swfu.edu.cn

A study on forest tree species classification of Shangri-La city based on Hyperion data

Yue Cairong
Southwest Forestry University

Hyperspectral remote sensing image has many characteristics, such as multi band, high spectral resolution, and the combination of the spectrum. This paper takes Shangri-La County of Yunnan Province as the study area. Use Hyperion hyperspectral remote sensing image as the main data and spectral reflectance curves of tree species measured by ASD FieldSpec4 portable spectrometer as supplementary data, to make the classification of Alpine oak, *Pinus densata, Picea-Abies* and *Pinus yunnanensis* as the four main trees species in study area.
Firstly, make the preprocessing work of Hyperion hyperspectral data to ensure that the data quality can meet the requirements of the classification of tree species. Then the characteristic band selection is divided into two aspects. One is analysis the measured hyperspectral data of 4 species with the method of original spectral selection, continuum removal, first derivative, second derivative and original spectral selection and first derivative to get the results of 5 kinds of characteristic bands group. The other one is make the dimensionality reduction to Hyperion hyperspectral data to with the method of band index and subsection principal analysis to get 2 kinds of characteristic bands group.

In tree species classification, firstly using the original spectral angle mapping method to classify hyperspectral images, and then use the method of maximum likelihood to classify the image of 7 kinds of characteristic bands group. Finally, through the compared with confusion matrix in the results of the 8 classification methods, we reach the following conclusion:

(1) The pixel reflection curve of each object in the Hyperion hyperspectral image become normal after pre-processed Data quality has been greatly improved to meet the requirements of the classification of tree species groups.

(2) The result of the test by Euclidean distance method in 5 characteristic band selected from measured hyperspectral data show that the selected characteristic bands of the 4 methods can effectively separate the 4 kinds of tree species. Show that subtle differences between tree species can be reflected in the hyperspectral image.

(3) Correlation between adjacent bands of Hyperion hyperspectral data is higher. Divided the data into 3 subinterval by the correlation between bands, calculation the band index and band principal component analysis in each interval. It can reduce the amount of computation and to achieve the purpose of dimensionality reduction.

(4) By comparing the final classification results can be drawn that the classification accuracy of all methods is above 75%. The classification accuracy is 83.09%, 81.95%, 79.97% and 79.46% respectively for the original spectral selection and first derivative, first order differential, the best band index and the original band difference. Higher than the classification using full spectral angle mapping method's accuracy of 79.08%, It shows that choosing the appropriate characteristic band can improve the accuracy of the classification of tree species effectively.

Email: cryue@163.com

Comparison of algorithms on forest canopy height estimation by PolInSAR with TerraSAR-X/TanDEM-X data

Zhang Wanqiu, Yue Cairong, Yan Peidong
Southwest Forest University

Forest canopy height is a critical parameter for forest management activities and various forest models. Polarimetric interferometric SAR (PolInSAR) technique has been widely used to retrieve forest height estimation from L band and P band SAR data. This paper focuses on the effectiveness of forest canopy height estimation by PolInSAR with X band. Three forest height inversion algorithms by PolInSAR, DEM Difference, Coherence phase / amplitude inversion and three-stage inversion, have been tested by TerraSAR-X/TanDEM-X quad-polarimetric and interferometric data. Forest inventory data is compared to the estimation results from these three algorithms. It is found that the estimated forest canopy height of three-stage inversion is relatively reasonable although it is a little bit higher than the record from inventory data. And the result also shows that the estimation from coherence phase/amplitude inversion is much lower than the height from inventory record, and DEM difference algorithm produces unreasonable negative forest canopy height in many pixels.

Email: wanqiu_mou@hotmail.com

Detection of deforestation in subtropical and tropical area using GF-1 data

Tan Bingxiang, Li Shiming, Liu Qingwang
Insitute of Forest Resource Information Techniques, CAF

According to the FAO report “Global Forest Resources Assessment 2015”, there was a net loss of 129 million ha of forest from 1990 to 2015, representing an annual rate of –0.13 percent. The biggest forest area loss occurred in the tropics and subtropics. Deforestation, or forest conversion is main reason for the forest area change. It is very important to develop a technique to quickly detect forest changes. In this study, a approach of optimum bands selection was designed to identify the forest change area at the regional scale over one-year period. The test site is located in Ningming county, Gouangxi Province, China, two dates of GF-1 WFV data were selected, May10, 2014 and April 19,2015. As results, B3 of second date, B3 of first date and B2 of second date were selected as the optimum bands. The results indicate that: (1) it is possible to obtain good quality optical images every year in the subtropical and tropical area because GF-1 has high temporal resolution (4 days). So the new deforestation area maybe able to be tracked every year. (2) Deforestation areas in the optimum 3 band combination imageis very clear and easy to classify. (3) The method developed in this study can quickly estimate the forest change area, it needs to be demonstrated for deforestation mapping over large areas.

Email: tan@caf.ac.cn

Division 5

Characterization of fluorescence performance within *Pterocarpus* genus for wood identification

Liu Bo
Wood Anatomy and Utilization Department, Research Institute of Wood Industry, Chinese Academy of Forestry

Within *Pterocarpus* genus,*P. santalinus* was listed in CITES (Convention on International Trade in Endangerd Species of Wild Fauna and Flora) Appendix II. However, it is difficult or even impossible to identify this species only depending on wood materials when wood anatomy was applied. Fluorescence is one of the importantcharacteristics of *Pterocarpus* wood. It used to be a key indicator for theidentification of *Pterocarpus* genus and could be potential clue for wood identification on a species level. In general, observation using naked eyes to determine the fluorescence reaction and fluorescence intensity of water/alcohol extractive from wood power is a mainly practical method with apparent limitations. In this paper, six species, i.e., *P.* santalinus、 *P.* tinctorius, *P.* marsupium, *P.* erinaceus, *P.* angolensis, *P.* soyauxii, were selected from *Pterocarpus* genus*.* The high performance liquid chromatography (HPLC), thin layer chromatography (TLC), gas chromatography-liquid chromatography-mass spectrometry (GC-LC/MS) and ultraviolet-visible spectrophotometer (UV-Vis), combined with principal component analysis and cluster analysis methods, were adopted to characterize the inter-species differences in fluorescence performance ofwood within *Pterocarpus* genus.A fluorescence fingerprint method was established to determine the correlation between sample morphology, extraction conditions, environmental factors and detection methods with fluorescence intensity, color and quenching of fluorescence. The present results could provide a new way to aid wood identification on a species level based on the traditional wood anatomical method.

Email: liubo@criwi.org.cn

High coumarins content of Calophyllum inophyllum seed, potential for medicinal sources

Budi Leksono
Centre for Forest Biotechnology and Tree Improvement

Nyamplung (*Calophyllum inophyllum*) seeds known as alternative sources of *biofuel*, have been revealed to contain coumarins compound that is potentially promising for medicinal sources for diseases therapy. Coumarins are components in seeds that need to be eliminated as a waste when *biofuel* production process is about to be conducted. This valuable coumarins as sources of drugs have added the values and functions of nyamplung seeds. Coumarins are elements of Phenylpropanoids compound which their derivates are pharmacologically essential for having different physiological activities (anti-HIV, anti-cancer, anti-inflammation, anti-oxidant, anti-bacterial, anti-coagulant, analgesic and comparative immune-modulation). The aim of this study is to examine variations of total coumarins content of nyamplung seeds from 12 nyamplung populations (6 Java island, 6 outside Java) throughout 7 islands in Indonesia. Results indicate very high variations between nyamplung stands in Indonesia for coumarins content. The ranges of coumarins content of seeds from Java and outside Java are0,101-0,354% and 0,261-0,412%, respectively. Variations were found to be higher when obtained from crude oil, both fresh and one year preserved, of materials from 7 islands in Indonesia, which are0,328-1,109% and 0,229-1,330%, consecutively. Coumarins content and variations between stands have shown to be higher in crude oil than in seeds.

Email: boedyleksono@yahoo.com

Biologically active substances of the different parts of birch betula pendula roth.

Dmitrii Vedernikov
Saint Petersburg State Forest Technical University

Various parts of the tree contain different substances which can be used to treat various human diseases. In the xylem and phloem of the birch contains squalene and betulaprenols, esters of sterols and fatty acids. The male buds of birch are rich in sterols and esters of fatty acids. Vegetative and female buds contain the aglycone of flavonoids and sesquiterpenoid of caryophyllane and gumulane types. Young leaves also contain flavonoids, sesquiterpenoids, fatty acids, triglycerides, where the main acid part of the ester is linolenic acid. In old leaves increases the number of waxes and disappear flavonoids and sesquiterpenoids. Sterols are oxidized to ketones in old leaves. Periderm of dark birch branches contains triterpene acids – oleanolic and betulinic. With age, the relative content of acids decreases due to the increase in the number of triterpene alcohol – betulin. Almost all parts of the tree, especially the bark contain more quantity of lupeol.

Polyprenols exhibit hepatoprotective properties. Flavonoids are good antiseptics. Sesquiterpenoid possess virucidal activity against influenza virus. Derived sitosterol - stigmasta-4-en-3-on is a promising tool in the treatment of benign tumors of the prostate and helps lower blood glucose during hyperglycemia effective androgen dependent disease. Oleanolic acid inhibits the formation of dihydrotesterone, has an inhibitory activity against the development of tumors. It is known for its hepatoprotective, cardio, antiatherosclerotic activity. Betulinic acid kills cancer cells of the skin, and contributes to a noticeable reduction of the tumor, anti-inflammatory and anti-HIV activity. Lupeol is an anti-arthritic, an anti-microbial agent, an antiprotozoal, an anti-cancerous, anti-diabetic, a cardioprotective, an anti-inflammatory, a skin protective agent, a hepatoprotective agent. Betulin possesses antioxidant, antitumor, hepatoprotective, antiviral, immunostimulatory and hypocholesterolemic properties. Squalene has a unique ability to regenerate cells, saturating them with oxygen, slows the aging process, that is, acts as a powerful antioxidant, improves the immune system (has immunostimulant, antibacterial, detoxifying and anti-inflammatory).

Email: trmoon1949@163.com

Crown of tree - the raw material for biologically active drugs

Viktor Ivanovich Roshchin
Saint Petersburg State Forest Technical University

Significant part of wood biomass from 20 to 40% remains in the forest and destroyed during timber harvesting. Crown is the most active part of the biosynthetic wood biomass and contains biologically active substances. The composition of the crown of the tree extractives conifers growing in Russia was determinated. Many chemical processing of crown are proposed and implemented to produce a biologically active product. Hydrocarbons, alcohols, liquid carbon dioxide - extractants for the extraction of active compounds from the coma. Drugs use in medicine, agriculture, food and cosmetic industries. The drug "Ropren" is gepatoprotektor, "Bioeffective A-320" treats gastrointestinal tract. Other groups of substances extracted from the crownare used as feed additives for of agricultural animals and poultry, bio-fertilizers and pesticides in crop production. Another substances are used as dietary supplements for food and cosmetic products.

Email: 114114597@qq.com

The chemical properties and combustion characteristics of torrefied masson pine

Hu Wanhe, Liu Zhijia, Mi Bingbing, Jiang Zehui, Fei Benhua
International centre for bamboo and rattan

Biomass resources are considered as a type of renewable, sustainable and clean energy feedstock, providing approximately 14% of the world's energy needs. To investigate chemical properties and combustion characteristics, masson pine was torrefied using GSL 1600X tube furnance in the argon atmosphere. The properties of torrefied masson pine were respectively determined through thermogravimetry (TGA), fourier transform infrared spectrometer (FTIR) and X-ray diffraction (XRD). Results showed that thermal decomposition of hemicelluloses, cellulose and lignin occurred during torrefaction process. Crystalline region of cellulose was destroyed when temperature was up to 250℃. The effect of torrefaction temperature was more significant than that of residence time. Torrefaction improved combustion characteristics of masson pine. The optimum process was 300℃ of torrefaction temperature and 2.0h of residence time. Combustion process of torrefied masson pine included drying, oxidative pyrolysis and char combustion. Torrefied masson pine had a lower H/C and O/C ratios, peak temperature of oxidative pyrolysis and char combustion and burnout temperature. It had a higher energy density, ignition temperature and activation energy. This data will be significant to understand the torrefied masson pine for energy product to directly combustion.

Email: 229738119@qq.com

Investigating pyrolysis and combustion characteristics of torrefied bamboo, torrefied wood and their blends

Mi Bingbing, Liu Zhijia, Hu Wanhe, Wei Penglian, Jiang Zehui, Fei Benhua
International Center for Bamboo and Rattan

Bamboo and masson pine was torrefied with 300 C of temperature for 2.0 h of residence time using GSL 1600X tube furnace in the argon atmosphere. Torrefied bamboo and masson pine particles were uniform mixed with different weight ratios. Pyrolysis and combustion characteristics were investigated through thermogravimetry (TGA). The results showed that pyrolysis and combustion process of all samples included three steps even though their characteristics were different. Torrefied biomass had a higher pyrolysis and combustion temperature, due to moisture and volatile removal and thermal decomposition of hemicelluloses, cellulose and lignin during torrefaction process. Torrefaction also increased high heating value, ash content and C/H and C/O ratio of biomass. The synergy of torrefied bamboo and torrefied mason pine was not found during pyrolysis and combustion process of blends. The results from this research will be very important and helpful to develop and utilize the wastes of masson pine and bamboo for energy products.

Email: 429543207@qq.com

The sustainable utilization of bamboo industrial processing residues for bioethanol production

Li Zhiqiang, Fei Benhua, Jiang Zehui
International Centre for Bamboo and Rattan

Bioethanol from bamboo is becoming an increasingly important objective of renewable bioenergy. Pretreatment has important effects on enzymatic hydrolysis and ethanol fermentation. Bamboo ages, bamboo parts, and pretreatment methods have important effect on glucose yield. The purpose of this research is to compare and contrast the bamboo enzymatic digestibility and ethanol fermentation after varies of pretreatment methods. The results indicated that besides pretreatment methods, lignin content and distribution and bamboo ages were more important factors affect enhancing enzymatic hydrolysis. The bamboo pretreated substrates with low lignin had high glucose yield of over than 90%. Almost all the glucose in hydrolyzates could be converted to ethanol after fermentation process. The highest ethanol yield could reach 95%. The sugars in the pretreated spent liquors were also used for ethanol fermentation after an efficient inhibitors removing process. The lignin in the residue of bamboo bioethanol process was liquefied for lignin foaming material. Sustainable development of bamboo biofuel and byproducts are outlined for bamboo industrial processing residues based on this study.

Email: lizq@icbr.ac.cn

Cell wall mechanical properties and microfibril angle of phyllostachys edulis in different growth period

Liu Cangwei[1], Wang Xinzhou[2], Zhao Rongjun[1], Su Minglei[1], Ren Haiqing[1], Wang Yurong[1,3]
1. Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing,100091, China
2. Nanjing forestry university, college of materials science and engineering, Jiangsu, Nanjing, 210037, China
3. Center for Renewable Carbon, University of Tennessee, Knoxville, TN 37996, USA

This study was focused on the fiber cell wall of *Phyllostachys edulis* in different growth periods and illustrated the micromechanical properties of the 4-5 years old moso bamboo was better than that of the immature and overmature moso bamboo at cell wall level. Bamboos aged 0.5a, 4.5a and 10.5a were harvested from Miaoshanwu plantation in Zhejiang province. The micromechanical properties and microfibril angle (MFA) were determined using nanoindentation combined with non-embedding sample preparation and the wide-angle X-ray scattering method. The microstructure and ultramicrostructure of moso bamboo cross-section was also observed for choosing the precise locations for nanoindentation experiments. The mean reduced elastic modulus and hardness of immature (0.5a), mature (4.5a) and overmature (10.5a) moso bamboo were 10.7GPa and 0.358GPa, 19.6GPa and 0.489GPa and 17.6GPa and 0.445GPa, and their MFA were 13.5^{o}, 8.43^{o} and 11.9^{o}, respectively. There was the highly negative correlation between their micromechanical properties and MFA. The results illustrated that the bamboo age have an influence on the fiber cell wall mechanical properties and microfibril angle of moso bamboo. The micromechanical properties were increased with bamboo age and achieved optimal micromechanical performances at mature, however, and then slightly decreased with bamboo age after the maturity.

Email: mugongsuolcw@163.com

Preparation and characterization of aminosilane-functionalized cellulose nanocrystal aerogel

Wu Yu
Nanjing Forestry University

Increasing carbon dioxide emissions are generally believed to contribute to global warming. Developing a novel amine-based adsorbent for capturing CO_2 can potentially mitigate the effect of these CO_2 emissions. In this study, we developed and optimized functionalization of cellulose nanocrystal (CNC) aerogel with aminosilane (N-(2-aminoethyl)-3-aminopropylmethyldimethoxysilane) (AEAPMDS). The amine-based CNC aerogel was characterized by several different techniques. The results showed that optimal grafting conditions as follows: the reaction temperature was 100 ℃; the reaction time 16 h; the amount of added AEAPMDS 4% (based on gel mass); the mass ratio of hydrogel to reaction medium 1/10. At this condition, the nitrogen element analysis showed the nitrogen content was 4.4% based on the dry aerogel mass. The FTIR and CP/Mas ^{13}C NMR spectra confirmed that the success of grafting of aminosilane on the CNCs. The X-ray diffraction illustrated that the crystalline index decreased marginally after the modification, but the crystal structure was preserved. TEM images of the cross-sections of AEAPMDS-CNC aerogels demonstrated that their three-dimension network structure was conserved after the modification, but the CNC surface was somewhat blur, and slight adhesions occurred between CNCs. Therefore, the modification procedures could be a promising candidate for the preparation of aminosilane-functionalized CNC aerogels.

Email: jianghua@njfu.com.cn

Hierarchical crystalline cellulose with intercalated long chain alkyl

Guo Juan[1], Du Wenbo[2], Wang Siqun[3], Yin Yafang[1], Gao Yong[2]*
1. Chinese Academy of Forestry
2. Xiangtan University
3. The University of Tennessee

With inspiration from the comb-like polymers having amazing architectures and topologies, such as hierarchical self-assembly, nanoscale confined crystallization as well as phase transition, biological nanocomposites involving the intercalation modification of flexible molecules are pursued. However, the fabrication of nanocrystals with flexible side chains chemically pended onto the crystalline lattice plane are difficult, which is hindered by the precise maintain of crystalline lattice plane structure during the chemical modification. In this paper, hierarchical crystalline cellulose with intercalated long chain alkyl was fabricated. Cellulose nanocrystals (CNCs) obtained by acid hydrolysis of cellulose were utilized as the crystalline matrix to react with N-octadecyl isocyanate. FTIR and elemental analysis results confirmed that the dense long chain alkyl brush has been formed on the cellulose backbone in CNCs. The anchored long chain alkyl crystallized in multiple crystalline forms crystal of hydrocarbon as investigated by DSC and XRD. Modified CNCs organize in a layered type structure; the flexible alkyl chains being fully extended and perpendicular to the (200) lattice plane in CNCs as shown in XRD results. In addition, modified CNCs displayed significant increase in their thermal property.

Email: guojuanchina@126.com

One-pot assembly of microfibrillated cellulose reinforced PVA-Borax hydrogels bearing self-healing and pH responsive properties

Lin Fengcai, Lu Beili, Jiang Xin, Wang Xueqin, Lin Xing, Chen Yandan, Chen Xuerong, Huang Biao

Fujian Agriculture and Forestry University

An facile and environmentally benign approach has been developed for the preparation of dynamic, multi-responsive and self-healing hydrogels from inexpensive bamboo pulp, poly(vinyl alcohol) (PVA) and borax. The microfibrillated cellulose (MFC) reinforced PVA-borax hydrogels were produced through a one-pot route in conjunction with ball milling and physical blending in tandem in aqueous medium. In this way, MFC particles could be efficiently generated and well-dispersed in polymer matrix, which have been verified by scanning electron microscopy. The rheology analysis exhibited close relationship of the mechanical strength with the MFC loading and ball milling time. Due to the dynamic equilibrium of the didiol-borax linkages and the reinforcement of MFC fibres, the hydrogels showed enhanced self-healing behavior and mechanical stiffness, which was also supported by rheology analyses. In addition, the hydrogels were found to be sensitive to the pH value. The hydrogels exhibit solvent or gel state with the change of pH value, and this sol-gel transfer can be successfully accomplished for 5 times while maintaining the shape and mechanical strength, further demonstrating the dynamic reversible behavior of our hydrogels.

Email: linfengcai8@163.com

Coaxial electrospinning and characterization of core-shell structured cellulose nanocrystal reinforced PMMA/PAN composite fibers

Li Chao, Huan Siqi, Liu Guoxiang, Han Guangping, Cheng Wanli

Northeast Forestry University

A modified coaxial electrospinning process including poly (methyl methacrylate) (PMMA) solution with different cellulose nanocrystals (CNCs) addition as sheath fluid and polyacrylonitrile(PAN) solution as core fluid was used for preparing excellent composite nanofibrous mats. Effect of different CNC addition on the morphology, thermal behavior as well as multilevel structure of the coaxial electrospun PMMA+CNCs/PAN composite nanofibers was investigated. Morphology analysis of the obtained nanofibrous mats clearly demonstrated that the composite nanofibers with core-shell structure were successfully produced with CNC presence. Furthermore, diameter of the composite nanofibers was getting smaller and more uniform with increasing CNC concentrations in the sheath fluid. For the thermal performance of the core-shell nanocomposite mats with CNC reinforced, the maximum thermal decomposition temperature was quite higher than electrospun pure PMMA, PAN as well as core-shell PMMA/PAN nanocomposites. The BET results showed that the specific surface area of the CNC reinforced core-shell composites was larger with increasing CNC addition. Finally, this study appliedanunique technique to make bio-nanofiller enhanced nanocomposites with core-shell structure for its potential applications in packaging and medical field.

Email: 710150865@qq.com

Fluorescent labeling of cellulose nanocrystals with amino acid spacer

Tang Lirong[1,2], Li Tao[1], Zhuang Senyang[1], Lu Qilin[1], Huang Biao[1]
1. College of Material Engineering
2. Jinshan College

Fluorescent labeled nanoparticles are expected to have potential applications in biological and imaging systems. In this study, in order to constructing the biocompatible fluorescent nanoparticles for pH-sensing, L-leucine amino acid is used as a spacer linker between cellulose nanocrystals (CNCs) and a pH-indicator dye (5 (and 6)-carboxy-2',7'-dichlorofluorescein, CDCF). Characterization by FTIR, NMR and XPS was used to follow the chemical modification, whereas the morphology is determined by AFM. According to the obtained results, CDCF fluorescein could be successfully labeled onto CNCs *via* L-leucine amino acid spacer linking, and the cellulose structure is stable during the labeling reaction. The fluorescent properties of the yielding pH-sensitive fluorescent CNCs (F-A-CNCs) were characterized by fluorescence spectrometer and imaged by confocal laser scanning microscope (CLSM). The result showed that the fluorescence intensity of F-A-CNCs increases with increasing pH of the buffer from 2.28 to 10.84.

Email: tanglr0201@126.com

Cellulose nanofibers/carbon nanotubes hybrid supercapacitors fabricated by LBL Assembly

Chang Huanjun[1], Lv Shaoyi[1], Wang Siqun[2,1]
1. Research Institute of Wood Industry, Chinese Academy of Forestry
2. Center for Renewable Carbon, University of Tennessee

The objective of this research was to build supercapacitors with favourable energy storage ability and mechanical properties through a simple and rapid method. Cellulose nanofibers (CNFs) based aerogels can provide a large surface areas to build high electrical power supercapacitors, but they do not have enough strength and sufficient energy density. Carbon nanotubes (CNTs) have been used to combine with CNFs obtained from TEMPO Method to fabricate CNTs/CNFs hybrid aerogels. The internal 3D structure of the aerogels can be controlled by adjusting the dispersibility of CNTs in CNFs aqueous solution, the conductivity and the mechanical properties of the aerogels have been improved on account of the addition of CNTs at the same time. Then, the nano-PPy – a kind of conducting polymer with high cationic surface charge and the CNTs were assembled inside the aerogels alternately layer by layer, and the electrodes based on CNTs/CNFs hybrid aerogels have been fabricated successfully. The 3D energy storage devices with hybrid aerogels electrodes can be integrated easily and they exhibit excellent energy storage ability and mechanical properties. In this way, supercapacitors based on aerogels substrates would show significant potential in the field of flexible and wearable energy storage device.

Email: changhj126@126.com

Cellulose nanofibers derived from wheat straw with a multi-step method: effect of the treatments on composition, structure, morphology and properties

Liu Qi[1,2,3], Dorothée Goffin[2], Aurore Richel[3], Nicolas Jacquet[3], Mario Aguedo[3], He Weqing[1], Guo Rui[1], He Wenqing[1], Li Haoru[1], Song Jiqing[1]

1. Institute of Environment and Sustainable Development in Agriculture (IEDA), Chinese Academy of Agricultural Sciences (CAAS)/Key Laboratory of Dryland Agriculture, Ministry of Agriculture, Beijing 100081, P.R. China

2. University of Liège-Gembloux Agro-Bio Tech. Innovation and Creativity Cell, Gembloux, BE-5030, Belgium

3. University of Liège-Gembloux Agro-Bio Tech. Department of Agrobiochem. Unit of Biological and Industrial Chemistry, Gembloux, BE-5030, Belgium

In this work, cellulose nanofibers were isolated from wheat straw by a multi-step process which provided a new environmentally friendly method for biomass cellulose utilization. The isolation processes involved steam explosion, acid hydrolysis and microwave-assisted hydrolysis treatments. The mechanical fibrillation was performed via microfludization treatment. The chemical components at different stages of treatment of fibers were analyzed showing increase in α-cellulose content and decrease in lignin and hemicellulose. The purity of the resulting cellulose fibers reached at 94.23%. Morphological characterization was done using various electron microscopies. The isolated nanofibers ranged in 10-60 nm and a very high aspect ratio. Fourier transform infrared spectroscopy (FT-IR) showed the effective removal of the non-cellulose components with each step. The crystallinity was increased with successive treatments as shown by the X-ray diffraction analysis (XRD). TGA studies revealed a better thermal stability for the isolated nanofibers compared with the resulting samples after each treatment. FT-IR, XRD, and TGA studies confirmed the removal of hemicellulose and lignin during the chemical treatment process. These results showed that it’s an effective way to prepare cellulose nanofibers, which will be possibly useful in green nanocomposites, auto industry and optically transparent films.

Email: liuqi@caas.cn

Self-assembly for hollow nanospheres with size tunable single holes derived from renewable enzymatic hydrolysis lignin

Xiong Fuquan[1], Han Yanming[1], Wang Siqun[1,2], Li Gaiyun[1], Qin Tefu[1], Chen Yuan[1], Chu Fuxiang[1]

1. Research Institute of Wood Industry, Chinese Academy of Forestry

2. Center for Renewable Carbon, University of Tennessee

A simple self-assembly route for fabricating lignin hollow nanospheres with size tunable single holes through employing pre-dripping lignin concentration was introduced. Thelignin hollow nanospheres were formed by dissolving enzymatic hydrolysis lignin in tetrahydrofuran and subsequently adding water into the system. The structure and formation mechanism of the hollow spheres was investigated. Results showed that increasing the pre-dropping lignin concentration brought about an increase of the diameter of the hollow nanospheres and the thickness of shell wall, while the diameter of the single hole, the surface area and the pore volume of the hollow nanospheres decreased. The highest surface area was 25.4 m^2 g^{-1} at pre-dropping lignin concentration of 0.5 mg/ml. The nanospheres formed a hydrophobic outside surface and a hydrophilic internal surface through gradually hydrophobic aggregation from outside to inside after phase inversion, and the preparation process of lignin hollow nanospheres had not produced a significant impact on the core structures of lignin. Moreover, the average diameter of lignin hollow nanospheres had no significant change after 15 days. The lignin hollow nanospheres with size

tunable single holes provide a new and green approach for a high-value-added application of lignin.

Email: xiongfuquan@126.com

Polyols with autocatalytic characteristics and polyurethane foams prepared from cardanol

Huo Shuping, Liu Guifeng, Kong Zhenwu
Institute of Chemical Industry of Forest Products, CAF

Global efforts to find renewable feedstock for the chemical industry are aimed at replacing fossil reserves and a reduction in environmental pollution by petrochemical products. Cardanol, obtained as a byproduct of the cashew processing industry, is an important renewable resource and a unique phenolic compound carrying a 15-carbon side chain in meta position with varying degrees of unsaturation. In this work, novel cardanol-based autocatalytic polyols (CAPs) were synthesized and used to construct polyurethane (PU) foams. The CAPs with high reactivity were obtained from the epoxidation of cardanol, followed by the ring opening reaction of epoxy group with amido-polyols, and the molecular structure of CAPs was characterized by FTIR and NMR spectroscopy. These autocatalytic polyols based on tertiary amine initiators could reacted with polyisocyanates in the presence of other additives per se to produce PU foams. The structure and performance of the PU foams were further investigated. Processing parameters as well as final thermo-mechanical properties of the prepared foams were evaluated and discussed. The results showed that the CAPs was suitable for the preparation of the rigid PUR foam and can replace a majority of petrochemical polyols in the rigid PUR foam formulation without tertiary amine catalyst.

Email: shuping_huo@163.com

Production and characterization of cellulose nanocrystals from abaca (*Musa textilis* Nee.)

Ronniel Manalo[1], Jessa Mae T. Loresto[2], Denise Ester O. Santiago[3], Ramon A. Razal[1]
1. Department of Forest Products and Paper Science,
College of Forestry and Natural Resources, University of the Philippines
2. Bataan 2020, Inc. Roman Superhighway
3. Department of Chemical Engineering, College Engineering and Agro-Industrial Technology,
University of the Philippines

The study dealt on the extraction of cellulose nanocrystals from Abaca (*Musa textilis* Nee). Abaca fiber (S2) was subjected to soda pulping, bleaching with calcium hypochlorite and purification processes to obtain alpha cellulose. Cellulose nanocrystals were isolated using controlled sulphuric acid hydrolysis. The effects of different acid concentrations (45 to 65%), temperature levels (40 to 55 °C) and duration (30 to 90 minutes) on the yield and morphological characteristics of the cellulose nanocrystals were determined. Chemical transformations of raw abaca to cellulose nanocrystals were analyzed using Fourier Transform Infrared Spectroscopy. Particle size and distribution were measured using Scanning Electron Microscopy and Zetasizer□, respectively. Results of the spectroscopic analysis indicate that nanocrystals can be obtained from abaca. The combination of the different parameters had significant effects on the yield (0 to 78.29 %) and the size and distribution of the cellulose crystals (ranging from micro to nano scales).

Email: rdmanalo@up.edu.ph

Effect of surfactant addition and surface modification with long-chain fatty acid chloride on spray-dying yield of nanocellulose suspension

Chan-Woo Park, Song-Yi Han, Seung-Hwan Lee
Kangwon National University

The cellulose nanofibril (CNF) can be isolated from wood cell walls by chemical and mechanical process. The CNF generally has 10-40 nm in diameter and excellent properties, such as high strength and stiffness, large specific surface area, low shrinkage-swelling and biodegradability. Industrial application of CNF is getting more interest, especially, in the research field of fiber-reinforced composite and bio-plastic. The CNF is mostly produced as aqueous suspension to maintain its nanoscale morphology. CNF is easy to be aggregated during drying process. The existence of water in CNF suspension hinders formation of tight structure of composite and reduces mechanical properties of the plastic composite. Thus, it is required to develop the drying method to improve the processability and strength properties of CNF-reinforced plastic composite. In this study, spray-drying method has been suggested to maintain nanoscale morphology of CNF. For increasing the efficiency of spray-drying, surfactant addition and surface modification of CNF using long-chain fatty acid chloride was tried.

Email: chanwoo8973@kangwon.ac.kr

A product of green technology from weeds for upliftment of livelihood of silkworm farmers

Rashmi Sehrawat[1], Pankaj Tewari[2]
1. Forest Research Institute, Dehradun, India
2. Regional Sericulture Research Station, Central Silk Board, Shashpur, Dehradun, India

In Northern region of India, sericulture is a subsidiary occupation. In general, two to four crops are being practiced by the Sericulturist. Silkworm rearers often face the problem of shortage of leaf quality and quantity during fifth stage of silkworm larvae, which leads to poor harvest of cocoons that ultimately resulted in low economic returns to the farmers. Besides, at the time of spinning, the problem of synchronization led to extended and irregular spinning of worms that makes the entire process more labour intensive and causes deterioration in the cocoon quality. These problems are mainly due to adverse effect on the physiology of the silkworm and can be dealt through regulation in the physiological process. Juvenile Hormone Analogue developed for control of pest in past were used by scientists and it was found that it is lethal when administered in higher dose. Therefore, there is an urgent need to find out cheaper and eco-friendly substitute of synthetic JHA.

By keeping the above problems and facts in the mind, an economic product was developed for the silkworm farmers under a joint venture with Regional Sericulture Research Institute, Sahaspur, Dehradun, India. After a continuous and arduous effort of 7 years of research and extensive trials in laboratory as well as in the field, a novel product named as 'S*amriddhi*' was developed. The application of '*Samriddhi'* reduced the cost of silk production in terms of mulberry leaves, manpower days, infrastructure and time besides giving a good quality and quantity of silk. The product will give an edge to the farmers in terms of competitiveness, financial gain and economic upliftment. Training cum awareness programmes for farmers about the product were also organized in different villages of Dehradun district.

Email: sehrawat82@gmail.com

Indian Butter Tree: an excellent source of nutrition and livelihood generation

Rashmi Sehrawat
Forest Research Institute

Cheura (*Diploknema butyraceae*) belonging to Sapotaceae family, is an important oil seed oftree-origin, distributed from India (Garhwal, Kumaun eastward toSikkim) to Nepal and Bhutan (sub Himalayan tracts and outer Himalayan ranges).InIndia, it occurs abundantly in Uttarakhand region.Fatty Oil in kernels known as phulwa or phulwara ghee andis used for cooking and frying of vegetables and food. It is also used for preparing medicines, ointment, candles, cream and other user friendly products. The cake produced after processing of Cheura is used as manure and has pesticidal properties.

Keeping the above facts in view, the present study was undertaken to evaluate the nutritional aspects and preliminary phytochemical analysis of cheura seeds. A high performance thin layer chromatography method for the separation of active constituents has been developed which would be helpful in identification and isolation of the chemical markers present in cheura seeds. Qualitative analysis of the different extracts of the plants has been done by the standard methods and with the help of this analysis nature of the compounds which have been present in the plant is being identified. This study will further help in developing the value added products from cheura seeds. The detailed results will be discussed during presentation.

Email: sehrawat82@gmail.com

Preparation and performance of calcium-enriched activated carbon monolith cemented by sticky rice–lime mortar

Chen Yandan, Huang Bizhu, Huang Mingjie, Huang Biao
Fujian Agriculture and Forestry University

Lime mud is a solid waste that results from the causticization reaction in alkali recycling process of paper manufacture industry, mainly composing calcium carbonate. In this work, calcium-rich powdery activated carbons with high specific surface area derived from Chinese fir sawdust from timber processing plants was prepared by physical activation effect of CO_2 gas released via lime mud decomposition.Compression molding of a mixture of calcium-rich activated carbons blended with cooked sticky rice soup was performed to fabricate sticky rice–lime mortar cemented column-shaped activated carbon monolith. Under the optimized conditions, the iodine adsorption value of the as-prepared activated carbon monolith was 410 mg g^{-1}, the compressive strength was 18MPa, and its resistance to water immersion was excellent. SEM and XRD analysis results indicated that components of the sticky rice–lime mortar bonding activated carbon monolith were cemented closely, and the carbonation crystallization process of the lime component integrated in activated carbon monolith could be regulated by the glutinous rice paste to form a compact microstructure. Such a biomimetic mineralization effect gives rise to outstanding performance of mechanical strength and water-resistence of the sticky rice–lime mortar cemented activated carbon monolith.

Email: fjaucyd@163.com

Induction of agarwood formation in aquilaria sinensis

He Haishan, Shen Huajie, Pan Zihong, Qiu Jian
Southwest Forestry University

Agarwood, or resinous wood, is an important raw material in the Asian cultures produced in trees of the thymelaeaceae family (agar trees). In the Buddhism ceremonies agarwood incense is preferred, in China it is for medicine and incense and it also is used in Middle East for production of expensive perfume. Agarwood contains high concentration of fragrant sisquiterpenes produced by living xylem parachyma cells. Agar trees do not normally produce sisquiterpenes or other wood extractives by by paranchyma cells in rays and included phloems. But sisquiterpenes can be produced when the stems are injured or possibly invaded by microorganisms such as certain fungi. Traditional supply has been depended on naturally occurring agarwood (natural agarwood), which is formed either by mechanical (wind and insects) damages to the stems and branches or microbial infections. Natural agarwood almost has been depleted and current supply of argarwood depends on artificial injury of agar tree stems, which is classified as induced agarwood. Mechanical injury of agar trees for agarwood production often results in death of trees. Therefore, wild agar trees are protected by the CITES agreement. Recent reports indicate formation of sisquiterpenes also can be induced with certain chemicals in living trees. This report presents initial results of various induced agarwoodfrom plantation *Aquilaria sinensis*.

Email: sand502@163.com

Research on the quantitative structure activity relationship of 24 cinnamaldehyde schiff base compounds

Wang Hui
Key Laboratory of Bio-Based Material Science and Technology of the Ministry of Education, Northeast Forestry University

Cinnamaldehyde amino acids Schiff base (CAAS) is a new class of safe, highly bioactive compounds, which could be developed as potential antifungal agents for control fungal infections. To explore the correlation between the molecular structure and antifungal activity of these new CAAS compounds against *Aspergillus niger* and *Penicillium citrinum*, a Quantitative Structure Activity Relationship (QSAR) analyses of antifungal activity of the CAAS compounds was conducted using CODESSA software. The relationship between the antifungal activity and the chemical structures of these cinnamaldehyde Schiff bases was determined and described using two QSAR models. The two QSAR models (R^2= 0.9288 for *Aspergillus niger*; R^2= 0.9008 for *Penicillium citrinum*) for these CAAS compounds was established. The results of the simulations using these models indicated that the higher the balance of charge distribution in the molecular structure, the better antifungal ability of the CAAS compounds. The polarity of the molecule and the ability to form hydrogen bonds might decrease the relative antifungal activity of the compound.

Email: 839618698@qq.com

Preparation of paraffin Micro and nano-emulsion and its application for wood preservation

Xie Guijun
Guangdong Academy of Forestry

A copper ammnonia-basedpreservative-treated wood has good decay resistance and anti-termite property. However, this product can't meet the requirement due to its split and distortion when using outside. Therefore, a new technology is necessary to solve this problem.

A paraffin micro and nano-emulsion of 107 nm has been produced by mixing low price and facile Paraffin wax and a series of fatty alcohol polyoxyethylene as emulsifying agent through Micro-emulsion Technology. This product can be discharged once the stirring procedure ended. This procedure runs continuous and saves energy more.

This type of micro and nano-emulsion can be mixed well with copper ammnonia-based preservatives after centrifugal treatment of 40 minutes with stirring speed of 4000 r/min. the dimensional stability of wood treated by mixture of 7% paraffin wax, fatty alcohol polyoxyethylene and 1% copper ammnonia-based preservatives can be reached to 85%, and this product does have any effect on the permeability of preservatives in wood.

Email: xgj80@sinogaf.cn

Preparation of cellulose nano fibril superhydrophobic coating with excellent durability

Huang Jingda[1], Lv Shaoyi[1], Wang Siqun[2,1], Fu Feng[1], Chang Huanjun[1]
1. Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing 100091, China.
2. Center for Renewable Carbon, University of Tennessee, Knoxville, Tennessee, 37996, USA.

Cellulosic nano fibril (CNF) is a kind of renewable and environmental material. Its large ratio of length to diameter and femininity are very helpful to form porous coarse structure that can contribute to roughness which is one of necessary conditions to fabricate superhydrophobic coating. At present, superhydrophobic coating has a limited application mainly due to its poor durability. Therefore, in this study, a semi-translucent CNF superhydrophobic coating with three dimensional network structure was prepared by a simple method. A CNF ethanolic suspension was sprayed onto a substrate surface previously covered with a kind of commercial adhesive, followed by modification via phase chemical vapor deposition (CVD) for reduction of surface energy. Results show that in addition to good superhydrophobic and self-cleaning properties, the coating revealed excellent durability and could resist sandpaper abrasion, knife-scratch, long time soaking, rainfall with artificial imitation and UV radiation etc, showing good potential development and application prospect.

Email: hjd1015@163.com

Preparation and thermal energy storage properties of paraffin/expanded graphite PCM loaded wood flour/HDPE composites

Guo Xi, Huang Yiheng, Cao Jinzhen
Beijing Forestry University

The paraffin/expanded graphite (EG) phase change material (PCM) was fabricated by absorbing liquid paraffin into EG, and then characterized by scanning electron microscopy (SEM), X-ray diffraction analysis (XRD), differential scanning calorimetry (DSC) and thermogravimetric (TG) techniques. Seven groups of wood flour/high density polyethylene (WF/HDPE) composites loaded with different mass ratios of PCM were then prepared, and their thermal and mechanical properties were investigated. The results showed that: (1) EG provides perfect form-stable function and shows no interaction with paraffin. The phase change temperatures of the PCMs are 24.5, 19.8 °C, which are close to those of pure paraffin (26.9, 19.6 °C). Its enthalpy is based on the mass fraction of paraffin in EG; (2) the addition of PCM showed a negative effect on the mechanical properties of WF/HDPE composites but favored heat conductivity coefficient. The thermal energy storage performance showed that the paraffin/EG PCM loaded WF/HDPE composites could slow down the temperature change, suggesting its potential as a temperature-controlling building material.

Email: 240881978@qq.com

Spatially resolved determination and molecular association of adsorbed water in wood cell wall examined by FTIR and Raman spectroscopy

Guo Xin , Qing Yan, Wu Yiqiang
Central South University of Forestry & Technology

Water adsorption has significant influence on the physical and mechanical properties of wood and wood-based materials, which determines its product application and performance.In order to gain a deeper understanding, the spatially resolved determination and molecular association of adsorbed water in wood cell wall was studied using micro-FTIR spectroscopy, confocal Raman spectroscopy and a specially designed sample cell, allowing take in-situ spectra under strictly controlled humidity conditions and enhance spectral resolution during adsorption process. *In situ* micro-FTIR spectra of wood cell wall with high resolution, high signal-to-noise ratio (SNR), high sensitive and real-time were acquired over a wide range of relative humidity (RH). As the RH increased from 0% to 98%, the characteristic peaks at 1733 cm^{-1}, 1604cm^{-1} and 1236 cm^{-1} exhibited a red-shift, showing that carboxyl C=O and C-O groups were active sites for water adsorption. Meanwhile, Chemical information from morphologically distinct cell wall regions was obtained and Raman images of lignin and cellulose spatial distribution were generated. Cell corner (CC) lignin concentration was the highest, and lignin concentration in compound middle lamella (CmL) was higher than that in S2 region. In contrast, cellulose distribution showed the opposite pattern-low concentration in CC and CmL and high in S2 regions. From these Raman images of lignin and cellulose spatial distribution, two particular points (A in CC and B in S2 region) whose diameters were one micron were studied as active sites for absorbed water spatial distribution. As expected, the absorbed water in these two regions was shown to increase over the full range of RH. However, the water absorbed in the A point which belonged CC region was smaller than that observed in the B point which was in S2 area. The present results suggested that absorbed water concentration in a distinct morphological region was not uniform and varies significantly.

Email: guocumt@163.com

Division 6

Effect of key priority forestry programs on off-farm employment: evidence from Chinese rural households

Liu Yue, Yao Shunbo
Northwest A&F University

This paper examines how three Key Priority Forestry Programs(the KPFPs) influence the rural off-farm employment time based on a long-term panel dataset spanning 18 years(1995~2012) of 6 provinces in China. The programs are the most significant forest policies,including the Sloping Land Conversion Program(the SLCP),the Desertification Combating Program around Beijing and Tianjin(the DCBT),and the Natural Forest Protection Program(the NFPP). A labor supply model with fixed and cluster effect is used to identify programs disparate impacts in different regions and different policy stages. We find the following results: (i)the overall effect of the SLCP is pronounced on off-farm participation time, but it weakens gradually after the fist policy stage; (ii)the DCBT's impact has a little less than the SLCP in increasing work time of farms who has already have off-farm jobs,while better than the SLCP during different subsidy policy stages; (iii)the NFPP's total effect is insignificant;(iv)moreover,forestry subsidies tend to be decoupled for farmers in China, of which the substitution effect is greater than the income effect that could increase a supply of no-agricultural labor hours. The research and policy implications of our work are discussed.

Email: liuyue1014@126.com

Reconstructing local forest history from cultural heritage: dendroarchealogical study of Saridag Monastery

Sainbayar Gombo, Byambagerel Suran, Baatarbileg Nachin
national university of Mongolia

Studying trees growth help to us know how to trees growth all past years and their growth changes due to the climate change, natural disturbances such as fire, defoliation and diseases and even human impact on trees. Therefore, this study focused on exploring history of local forest stands using wooden elements of a monastery, snags and living tree cores from surrounding forests. We had collected 12 living trees, 6 disks from log and 21 sample from ruins of Saridag Monastery, Mongolia. All samples were processed with standard method of dendrochronology, and identification of wood species was made by wood anatomical sections. As a result, we determined logs were cut in 1660 which matched documented date of monastery establishment. Some other small samples were cut in 1690 which explained that it took more than thirty years to build this monastery. Collected wood samples were identified as Scots pine (*Pinus sylvestris* L.) by their anatomical features . Developed tree ring chronology was analyzed by 50 and 100 year to see history of forest growth. It indicated that average growth of first 300 years was higher than last 200 years growth.

Email: sain112288@gmail.com

Adaptation of Asia-Pacific forests to climate change

Wang Guangyu
Faculty of Forestry, University of British Columbia

Climate change is an immense threat to the stability and productivity of forest ecosystems in the Asia-Pacific region. Potential changes to or loss of forests will have drastic environmental impacts on biodiversity, ecosystem function and resilience, as well as immense socio-economic impacts on people and economies dependent on forest resources and ecosystem services. Despite their importance, there is a lack of information and tools focused on Asia-Pacific ecosystems and economies, which are necessary to understand the potential effects of climate change and develop regionally-specific adaptation and mitigation strategies. The project Adaptation of Asia-Pacific Forests to Climate Change aims to address this lack of knowledge and tools and to increase the adaptive capacity of Asia-Pacific forest ecosystems. This objective has been achieved through: development of a high-resolution climate model, ClimateAP, applicable to any location in the region; development of ecological models to project how climate change will affect suitable climatic conditions, regeneration, and productivity of forest tree species; development of tools to assess the most effective local management strategy based on management objectives and projected impacts of climate change; evaluation of models to assess forest fire risk and the relationship between forest fire and climate change; assessment of ecosystem carbon storage using LiDAR; and evaluation of how vegetation dynamics respond to climate change using remote sensing technology. All project outputs were developed with ease of communication in mind, as to ensure that information can be clearly disseminated and easily understood. This is necessary to allow for project findings to be used in the development of effective policy and sustainable forest management strategies related to adaptation and mitigation of forests to climate change.

Email: guangyu.wang@ubc.ca

Division 7

Studying climate and human influence of forest fires in Mongolia and its implication to forest management

ByambagerelSuran
National university of Mongolia

The aim of the study was to assess climate and human effects on past fire occurrence from 1700 to 2010 in northeast of Mongolia. Using crossdated fire-scar chronologies from 29 sites, we examined climate effects on local and regional fire events derived from these reconstructed fire chronologies. While human effects were examined by population of local sites, road access to forest area, and biomass removal by livestock grazing and wood harvest in this region. Evaluating human role in past fire occurrence was quite hard since historical records of fire ignition were quite short only starts from 1980s. Although logging may have lead road access to forest areas, there were fewer fires in logging era in this mountain range. Utilization of forest areas also played main role in recent fire occurrence. Increasing of livestock grazing close forested areas, timber logging, and establishments of protected and national parks in forest areas may be associated with recent fires. Assuming local fires may effected by human, we used some secondary data review for archived documents of local administration including jury, law enforcement documents. Our results suggested that there is no direct linear relationship between human factors and fire occurrence while climate is definitely playing main role in regional fire years in forests of Northeast Mongolia.

Email: treeringlab@num.edu.mn

High species diversity of *calonectria* isolated from Eucalyptus plantations and nurseries in South China

Li JieQiong[1,2], Liu QianLi[2], Irene Barnes[3], Jolanda Roux[4], Michael J.Wingfield[1], Chen ShuaiFei[1,2]
1. Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Pretoria, 0028, South Africa
2. China Eucalypt Research Centre (CERC), Chinese Academy of Forestry (CAF), ZhanJiang 524022, GuangDong Province, China
3. Department of Genetics, FABI, University of Pretoria, Pretoria 0028, South Africa
4. Department of Plant and Soil Sciences, FABI, University of Pretoria, Pretoria, 0028, South Africa

Diseases caused by species of *Calonectria* represent a serious threat to the growth and sustainability of *Eucalyptus* plantations in China. The disease symptoms caused by these fungi mainly include leaf blight on trees in plantations and rotting of stems and leaves in nurseries. Extensive surveys have recently been conducted where *Calonectria* spp. were collected in *Eucalyptus* plantations and nurseries of the FuJian, GuangDong, GuangXi and YunNan Provinces in South China. The aim of this study was to identify these *Calonectria* isolates. In total, 161 *Calonectria* isolates were identified based on comparisons of DNA sequence data of the β-tubulin, calmodulin, histone H3 and translation elongation factor-1α gene regions, and including their morphological features. Thirteen species were identified, including *Calonectria asiatica*, *Ca. arbusta*, *Ca. chinensis*, *Ca. eucalypti*, *Ca. hongkongensis*, *Ca. mossambicen*, *Ca. pentaseptata* and six novel taxa. Results of this study suggest that species diversity of *Calonectria* in China is high. Consequently, a more comprehensive understanding of the species diversity and distribution of *Calonectria* in China should be sought. This will contribute to the development of integrated disease management strategies for the diseases caused by species of *Calonectria* in *Eucalyptus* plantations and nurseries.

Email: shuaifei.chen@gmail.com

Botrytis eucalypti, a novel species isolated from diseased Eucalyptus seedlings in South China

*Liu Qianli, Li Guoqing, Li Jieqiong, Chen Shuaifei**
China Eucalypt Research Centre (CERC), Chinese Academy of Forestry (CAF), ZhanJiang 524022, GuangDong Province, China

Eucalyptus has become a preferred species for the production of industrial products and also for the protection of natural forests in South China. Many diseases affect these trees, both on plantations and in nurseries. One such disease in *Eucalyptus* nurseries is gray mold caused by species of *Botrytis*. Symptoms of gray mold were recently observed on stems and leaves of *Eucalyptus urophylla* × *Eucalyptus grandis* seedlings in nurseries in ZhanJiang, GuangDong Province, South China. Diseased plant parts were covered with mycelium, conidiophores and

conidia of the causal pathogen. The fungus was identified on the basis of DNA sequence comparisons and morphological features, and its pathogenicity was tested on three *Eucalyptus* clones. As inferred by sequence comparisons of glyceraldehyde-3-phosphate dehydrogenase (*G3PDH*), heat-shock protein 60 (*HSP60*), DNA-dependent RNA polymerase subunit II (*RPB2*), necrosis and ethylene-inducing proteins (*NEP1* and *NEP2*) gene regions, combined with morphological characteristics, the fungus represents a previously undescribed species of *Botrytis*. A description of the fungus, designated as *Botrytis eucalypti* sp. nov., is provided. Pathogenicity tests demonstrate that *B. eucalypti* isolated from *E. urophylla* × *E. grandis* seedlings is virulent on all three tested *Eucalyptus* clones.

Email: shuaifei.chen@gmail.com

Quambalaria leaf and shoot blight on eucalypts in South China

Li Guoqing[1], Liu Qianli[1], Michael J. Wingfield[2], Chen Shuaifei[1,2]
1. China Eucalypt Research Centre (CERC), Chinese Academy of Forestry (CAF)
2. Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria

Species of *Quambalaria* include several important pathogens of eucalypts, mainly causing leaf and shoot blight on species of *Eucalyptus* and *Corymbia*. *Qumbalaria* spp. that cause diseases of eucalypts are typically Australian fungi and some species have moved globally as plantation forestry has expanded utilizing non-native species of these trees. The first of these species to appear outside its native range was *Quambalaria eucalypti* that has now been recorded in Africa, Asia, Europe and South America. Another species, *Quambalaria pitereka* was first recorded on *Corymbia citriodora* trees in the GuangDong Province of China in 2007. This species is specific to eucalypts in the genus *Corymbia*. Recent disease surveys in the GuangDong and HaiNan Provinces have revealed extensive shoot and leaf dieback, as well as stem cankers on young *E. urophylla* × *E. grandis* trees. To identify the fungus causing the disease, comparisons of DNA sequence data for the ITS and 5.8S regions were conducted. Results showed that three species of *Quambalaria* were present. These include *Q. pitereka* from *C. citriodora*, *Q. eucalypti* from *E. urophylla* × *E. grandis*, both solated from young leaves and shoots of eucalypts at a single site. *Quambalaria simpsonii* was isolated from stem cankers of *E. urophylla* × *E. grandis* at five different sites in GuangDong and HaiNan Provinces. To the best of our knowledge, this is the first report of *Q. eucalypti* in Asia and the first report of *Q. simpsonii* in China on *Eucalyptus* trees.

Email: cerccsf@126.com

Japanese larch and its hybrid grown in two soils in a free-air O_3 enrichment regime: growth and photosynthetic pigments

Eugenios Agathokleous[1], Amelie Vanderstock[2,3], Tetsuto Sugai[1], Saki Fujita[1], Takayoshi Koike[1]
1. Silviculture & Forest Ecological Studies, Hokkaido University, Sapporo, 060-8589, Japan
2. HUSTEP, Hokkaido University, Sapporo, Japan
3. Biological Institute, The University Of Sydney, Australia

The aim of this study was to assess the effects of elevated O_3 levels (EOZ) on Japanese larch (JL) and its hybrid (*Larix gmelinii* var. *japonica* × *L.kaempferi* (HL)) grown in brown forest soil (BF) or BF mixed with volcanic ash soil (VA), with no root limitations. The plants were exposed to EOZ (≈60-70 nmol mol^{-1}) in two growing seasons, and measurements were carried out at the end of

the second growing season. EOZ induced alteration in the stem shape, which was different between taxa. Both taxa had altered stem shape in EOZ when grown in VA; however, when the resources where more abundant (*i.e*. BF) only HL had altered stem shape. EOZ led to decreased canopy thickness, mean crown spread, stem volume, estimated stem dry mass, total chlorophyll and carotenoid contents and the ratio of chlorophylls to carotenoids of both taxa in both soils. Despite the reduced content of pigments, plants did not have EOZ-induced ratio between chlorophyll a and b contents, and there was no sign for pheophytinization through the estimated OD_{435}/OD_{415} index. It seems that important taxa will be at risk under future increases in background O_3 levels.

Email: evgenios@for.agr.hokudai.ac.jp

Reduced insect grazing in white birch stands under free-air O_3 enrichment

Amelie Vanderstock[1], Saki Fujita[2], Wataru Inoue[2], Eugenios Agathokleous[1], Masahiro Nakamura[3], Takayoshi Koike[2*]
1. HUSTEP, Hokkaido University, School of Engineering
2. Hokkaido University Graduate School of Agriculture
3. Hokkaido University Forests

Tropospheric ozone pollution is a critical environmental stress to Asian forests. Excess ozonecan reduce plant productivity. Ozone induced changes to leaf quality, defense allocation and biogenic volatile organic compounds (BVOCs) may also substantially alter insect herbivory. We used a free-air ozone enrichment system to study the effects of elevated ozone levels on insect herbivory of white birch, *Betula platyphylla* var *japonica,* in nutrient rich and poor soil. We visually assessed herbivorous insect damage over 15 weeks by feeding guild. Both chewer and skeletonizer damage of *Agelastica coerula* was reduced under elevated ozone treatment. The pattern of grazing of the two feeding guilds was different mainly from mid. June to mid. July when chewers dominated. Our results show no effect of soil quality regardless of ozone treatment, hence do not support the carbon nitrogen balance hypothesis. Rather, changes to BVOCs may be more important than changes in leaf quality and defense underelevated ozone levels. We recommend further investigation of shifts in herbivorous insect oviposition as a mechanism for reduced herbivory in this system. Inconsistences between plant defense theory and observed insect behavior necessitate the consideration of community interactions when investigating ozone effects on forests.

Email: ameliemareva@gmail.com

Effects of Ozone and Ammonium sulfate on the growth and photosynthesis of Japanese larch and its hybrid larch F1

Tetsuto Sugai[1], Toshihiro Watanabe[1], Kazuhito Kita[2], Takayoshi Koike[1]
1. Hokkaido University
2. Hokkaido Forestry Research Institute

The concentration of ground-level ozone (O_3) and nitrogen (N) deposition has been increasing due to rapid industrial development in Asia. O3 has oxidation stress on chloroplast and photosynthesis. Excess N deposition causes soil acidification, and several heavy metal ions (Ca^{2+},

Mg^{2+}, etc.) leach, resulting in the inhibition of tree growth. These atmospheric environment changes have been monitored in Hokkaido, the northern island of Japan. In Hokkaido, Japanese larch (Larix kaempferi) is a representative afforestation species and widely planted. Additionally, hybrid larch F1 (Larix gmelinii var. japonica × Larix kaempferi) are developed and are promising afforestation species. Therefore, we should evaluate physiological and growth responses to the change of atmospheric environment for future reforestation. We hypothesized that application of $(NH_4)_2SO_4$ will cause soil acidification, and increases O_3 sensitivity. In this experiment, we evaluated growth and photosynthesis responses of Japanese larch and F1 seedlings to O_3 and $(NH_4)_2SO_4$ by using OTC (Open-Top Chamber, daily mean 70 ppb of O_3). The amount of decrease in the growth of F1 to O_3 got worse with $(NH_4)_2SO_4$ although there are no significant in photosynthesis. On the other hand, The amount of decrease in the leaf N content of Japanese larch to O_3 increased with $(NH_4)_2SO_4$.

Email: tetsuto.922@gmail.com

Urban trees: an efficient tool for monitoring metallic elements' pollution - a case study from biomonitoring in playgrounds in Attica, Greece

Eugenios Agathokleous[1], Costas Saitanis[2], Katerina Lappa[2], Georgia Ntatsi[3], Takayoshi Koike[1]*
1. Silviculture & Forest Ecological Studies, Hokkaido University, Sapporo, 060-8589, Japan
2. Agricultural University of Athens, Laboratory of Ecology and Environmental Sciences, Iera Odos 75, Votanikos, Athens, Greece
3. Agricultural University of Athens, Laboratory of Vegetable Production, Iera Odos 75, Votanikos, Athens, Greece

We conducted a biomonitoring exploration of metallic elements (Fe, Mn, Zn, Mg and Ca) pollution using leaves of *Platanus orientalis* L. and *Cercis siliquastrum* L. trees, grown in 16 playgrounds scattered throughout greater region of Attica basin, Greece. We found significant correlations between Mg-Mn, Mg-Ca, Fe-Zn, Fe-Mg, Fe-Ca, Zn-Mg, Zn-Ca and Mg-Ca. Multivariate analysis revealed highly structured data. Statistically significant difference was observed between washed and unwashed leaves, between tree species and among regions for all the elements. The highest concentrations of Fe were observed at Aspropyrgos regions due to a metallurgical industry operating nearby. The highest concentrations for Mn and Zn were observed at Votanikos and Keratsini respectively while for Mg and Ca were observed at Agia Paraskevi. For all the elements, the lowest concentrations were observed in the low polluted Ekali region. A high spatial variability of the levels of the measured elements was observed across the playgrounds in the greater region of Athens. Leaves of *Platanus orientalis* L. and *Cercis siliquastrum* L. can serve as useful materials for biomonitoring of metallic elements in urban forest ecosystems for both ecosystem health and human exposures.

Email: evgenios@for.agr.hokudai.ac.jp

Proteomic response of *Machilus pauhoi* saplings to ambient and elevated ozone

Chen Zhan, Shang He, Cao Jixin, Yu Hao
institute of forest ecology, environment and protection, Chinese academy of forestry

In the present study, gel-based proteomics was used to reveal molecular mechanisms underlying responses of the Chinese endemic species *Machilus pauhoi* to elevated ozone (O_3). Of 45

differentially expressed proteins, 20 were identified. Gene ontology analysis showed that most of these proteins were related to defense responses and antioxidant activity. Meaningfully, we detected four proteins that have not previously been well characterized in O_3 stress, including glycine-rich RNA-binding protein 7 (GRP 7), beta 1,3-glucanases 2 (BGL2), 30S ribosomal protein S10 and voltage dependent anion channel 1 (VDAC1). The expression of GRP7 was decreased by O_3 stress, reducing stomatal aperture, which could decrease the amount of O_3 entering into plants. BGL2 was down-regulated after O_3 exposure, which may have lowered the plant resistance to pathogenic fungi and increased resistance to viruses. The 30S ribosomal protein S10, with an important role in protein synthesis, was more expressed, helping sustain protein synthesis that was depressed by O_3. The different expression of GRP7 and the 30S ribosomal protein S10 may be regarded as self-regulation of plants to acclimate to O_3 stress. The results showed that proteins of leaves responded differently to ambient and elevated O_3, and elevated O_3 had a great effect on *M. pauhoi* saplings at the proteome level.

Email: chenzhan0508@126.com

Effects of elevated ozone levels on carbon metabolism of *Phoebe bournei* and *Phoebe zhennan* in subtropical China

Chen Zhan
institute of forest ecology,environment and protection, Chinese academy of forestry

To assess the impacts of ozone (O_3) on carbon metabolism of subtropical broadleaved tree species, seedlings of *Phoebe bournei* and *Phoebe zhennan* were exposed to elevated O_3 levels in open-top chambers (OTCs) from June to November 2014. Three treatments in nine OTCs were performed in total including charcoal-filter air (CF) as a control treatment, low O_3 treatment 'O3-1'(~100 nl l^{-1}), and high O_3 treatment 'O3-2' (~150 nl l^{-1}). The results showed that elevated O_3 levels significantly decreased the net photosynthesis rates (P_n), stomatal conductance (g_s) and leaf, root, and total biomass of both species. Elevated O_3 significantly decreased the root/shoot ratio of *P. bournei* but not of *P. zhennan*. O3-1 treatment significantly increased WSC and TNC concentrations in leaves of in *P. bournei* and *P. zhennan*, starch in leaves of *P. bournei* in comparison to the control treatment (CF) whilst O3-2 treatment significantly decreased WSC and TNC in leaves of *P. bournei*, compared with CF. The contents of polysaccharide, starch and TNC contents in fine roots of both species increased initially with increasing O_3 concentration but then fell. Our results suggested that elevated O_3 levels have significant impacts on carbon metabolism of both the two species with differential responses between tree species and organs such as leaf and root.

Email: chenzhan0508@126.com

Impact of elevated ozone and moderately drought on the emission of isoprene and gas exchange of hybrid Poplar clone

Yuan Xiangyang[1,2,3], Vicent Calatayud[1,4], Gao Feng[1,2], Silvano Fares[5],
Elena Paoletti[6], Tian Yuan[7], Feng Zhaozhong[1,2,3]
1. Chinese of Academy of Sciences
2. College of Resources and Environment, University of Chinese Academy of Sciences, Beijing
3. State Key Laboratory of Desert and Oasis Ecology, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi

4. Fundación CEAM, c/Charles R. Darwin 14, Parque Tecnológico, 46980 Paterna, Valencia, Spain
5. Research Centre for Soil-Plant System, Council for Agricultural Research and Economics, Rome, Italy
6. IPSP-CNR, Via Madonna del Piano 10, 50019 Sesto Fiorentino (Florence), Italy
7. School of Food, Beijing Technology and Business University, Beijing

The impacts of elevated ozone and drought on isoprene emission have been previously studied individually, but the interaction between both factors on the emission has not been considered yet. In this study, we investigated the isoprene emission from hybrid clone 546 (*Poplus. deltoides cv. '55/56' x Poplus.deltoides cv. 'Imperial'*) with different leaf positions. Consistent with A_{sat} and chlorophyll contents (SPAD), isoprene emission was dependent on leaf position, ozone and drought treatments. Ozone induced a significant decrease in isoprene, $A_{sat}$and SPAD. However, drought interacted positively with ozone, increasing the decline in A_{sat}, SPAD and isoprene emission. The effects were more evident in middle-level leaves, whereas upper leaves were less affected by ozone and drought (and their interaction). The isoprene emission was significantly correlated with plant photosynthesis, but not with stomatal conductance. The severe drop in isoprene emission by ozone and drought treatments occurred only when a certain threshold (like AOT40>6.6 ppm.h) was exceeded. These results suggest that high doses of ozone inhibited the isoprenoid pathway whereas an enhanced emission of volatile isoprenoids with the low doses of ozone and moderate drought. The effective antioxidants protection of isoprene in plants seems to be clear only in early stage of the O_3 exposure. When plants were impaired by O_3, the emitted isoprene was not scavenging oxygen radicals any more whether drought increased isoprene emission.

Email: xyyuan_st@rcees.ac.cn

Effects of air pollution on morphological characteristics of cones and pollens of Pinus sylvestris L

Tsengel Batkhisihg, Jamiyansuren Sandagdorj, Zorigsaikhan Bayar
National University of Mongolia

The aim of this study is to determine the morphological characteristics of cones and pollens of Pinus sylvestris L (Scots pine). The average length of the pollen was measured 9.3 mkm, and the width was 11.4 mkm. Compared with results of previous study which conducted by Jamyansuren S. and Suntsov A.B during the period of 1983 to 1985, the current morphological measurements of cones have decreased by 5 mm and number of cone scales reduced by 12.6.
Cone and pollen samples were taken from Scots pine forest in Jargalant pass of Bogd Khan Mountain which elevated 1740 m above sea level (N47 48'56.8" E106 51'48.1").

The weather data from 1983 to 2012 at BogdKhaan Mountain showed that average temperature increased by + 0.4 C - + 0.8 C and temperature during the coldest period warmed by 3 C - 6 C. Decreased morphological changes of pollens and cones for Scots pine are highly dependent on air pollution and not on climate change. Also observed decreased the size and abnormality of pollens in BogdKhaan Mountain also confirmed our results.

Consequently, these growing-up some of pollen abnormality show that natural regeneration process of Scots pine will be limited in the future. Accordingly, these abnormality and decreasing numbers of cones and pollens will shrink stand adaptation of Scots pine forests and their

immunity in a facing climate change on natural regeneration of these forests in BogdKhaan Mountain.

Email: tsengel@seas.num.edu.mn

Calculating stomatal ozone fluxes from aggregated data: implications for passive sampler measurements

Vicent Calatayud[1],Jose Jaime Diéguez[1],Pierre Sicard[2],
Marcus Schaub[3],Alessandra Demarco[4]
1. Fundación CEAM, c/ Charles R. Darwin, 14, Parque Tecnológico, Paterna, 46980, Spain.
2. ACRI-HE, 260 route du Pin Montard, 06904 Sophia-Antipolis Cedex, France
3. Swiss Federal Research Institute WSL, Zuercherstrasse 111, 8903 Birmensdorf, Switzerland
4. ENEA, CR Casaccia, Via Anguillarese 301, Roma, Italy.

Current ozone (O_3) levels are high enough to negatively affect vegetation and may become worse in the future. Ozone risk assessment has recently shifted from exposure-based to flux-based metrics. Modelling stomatal O_3 fluxes requires of hourly O_3 and meteorological data that are not always available. Large datasets of O_3 concentrations measured with passive samplers exist worldwide, providing usually weekly to monthly means. Based on data from 24 Spanish air quality stations, we tested the errors of using weekly to monthly aggregated data (simulating passive sampler measurements) instead of hourly data for O_3 flux calculation. Four approaches and 3 different parameterizations were tested. For POD0 (Phytotoxic Ozone Dose with no threshold), the errors due to data aggregation were below 10% for three of the methods. Aggregations from 1 week to 1 month yielded similar errors, which is important in terms of cost-efficiency of the chosen passive sampler exposure periodicity. A major limitation of these approaches is that they are not suitable for high POD thresholds, and that accuracy of the measurements with passive samplers has to be strictly assured, in order to finally obtain acceptable errors.

Email: vicent@ceam.es

Temporal trends and spatial patterns of ground-level ozone in Spain

Vicent Calatayud[1], Jose Jaime Diéguez[1], Pierre Sicard[2]
1. Fundación CEAM, c/ Charles R. Darwin, 14, Parque Tecnológico, Paterna, 46980, Spain.
2. ACRI-HE, 260 route du Pin Montard, 06904 Sophia-Antipolis Cedex, France.

Ozone concentrations (O_3) from more than 170 air quality stations distributed throughout all Spain have been analyzed for the period 2000-2012. Lower O_3 concentrations are observed at the Atlantic coast of Spain, due to climatic conditions less favorable for O_3 formation and re-circulation processes The highest O_3 levels were measured at rural stations above 800 m.a.s.l., followed by rural stations below this altitude. Lower values were measured at suburban and especially at urban stations. Considering all rural stations, a slight but significant increase of O_3 with altitude was observed. Different O_3 metrics relevant for human health and vegetation protection have been calculated for the different stations. AOT40 for the protection of forest trees is largely exceeded at many of the rural sites. Between 200 and 2012, a positive trend in O_3 concentrations was observed at many urban and suburban stations, while rural stations showed smaller changes. This increase at urban sites is mostly related with a low O_3 tritiation by NO due to reductions in

local NOx emissions. Implications of the current O_3 levels and observed trends are discussed in relation to protection of vegetation.

Email: vicent@ceam.es

Spatiotemporal trends in ground-level ozone concentrations and metrics in France over the time period 1999-2012

Pierre Sicard[1], Philippe Rossello[2]
1. ACRI-HE, 260 route du Pin Montard, BP 234, 06904 Sophia Antipolis cedex, France
2. GeographR, 1 rue de Taulignan, 84000 Avignon, France

The hourly ozone (O_3) data from 332 background monitoring stations, spread in France, were analyzed over the period 1999-2012 and short-term trends were calculated. In the current climate change context, the calculation of human health- and vegetation-relevant metrics, and of associated trends, provides a consistent method to establish proper and effective policies to reduce the adverse O_3 effects. The generation of optimal O_3 maps, for risk and exposure assessment, is challenging. To overcome this issue, starting from a set of stations, a hybrid regression-interpolation approach was proposed. Annual surface O_3 metrics, O_3 human health metrics (e.g. SOMO35) and O_3 vegetation impact metrics (AOT40) were investigated at individual sites. Citizens are more exposed to high O_3 levels in rural areas than people living in the cities. The annual mean concentrations decreased by - 0.12 ppb.year-1 at rural stations, and the significant reduction at 67% of stations, particularly during the warm season, in the number of episodic high O_3 concentrations (e.g. P98, - 0.19 ppb.year-1) can be associated with the substantial reductions in NOx and VOCs emissions in the EU-28 countries since the early 1990s. Inversely, the O_3 background level is rising at 76% of urban sites (+ 0.14 ppb.year-1), particularly during the cold period. This rise can be attributed to increases in imported O3 by long-range transport and to a low O_3 titration by NO due to the reduction in local NOx emissions. The decrease in health-related and vegetation-relevant O_3 metrics, at almost all stations, is driven by decreases in regional photochemical O3 formation and in peak O_3 concentrations. The short-term trends highlight that the threat to population and vegetation declined between 1999 and 2012 in France, demonstrating the success of European control strategies over the last 20 years. However, for all exposure metrics, the issue of non-attainment of the target value for O_3 persists in comparison with the objectives of air quality directives. This study contains new information on the 1) spatial distribution of surface O_3 concentration, 2) exceedances and 3) trends to define more suitable standards for human health and environmental protection in France.

Email: pierre.sicard@acri-he.fr

Incidence of aphid (*Aphis craccivora* Koch.) infesting som plant leaves (*Machilus bombycina* King) and their control by using bio-pesticides

Sunil Ghosh
BCKV (Agril. University)

Som plant *(Machilus bombycina* King) is an important forest tree cultivated as community forestry, useful for rearing of muga silk worm (*Antheraea assama* Ww).Nutritional value of leaves plays an important role in larval growth and silk productivity. The plant also has timber values. The plant is susceptible to various insect pests of which *Aphis craccivora* Koch. causes heavy damage to tender leaves of the plant. Initially its population was recorded higher (10.88-12.79 aphid/leaf) during January-February and then declined. Higher population (17.45-24.98/leaf) was maintained during 2nd week of September to 1st week of October. Aphid incidence showed positive correlation (p= 0.05) with temperature and relative humidity. Studies were made to evaluate efficacy of extracts from plants such as *Pongamia*, *Nicotiana*, *Polygonum*, *Spilanthes* and botanical insecticide azadirachtin (1500ppm) against aphids infesting som leaves. Immidacloprid, the chemical insecticide was the most effective providing more than 80% aphid suppression followed by azadirachtin. *Polygonum* extract was very effective against the aphid (>60% suppression). As som plant leaves are the major food component of muga silk worm rearing, toxic synthetic insecticide should not be used. Plant extracts (bio-pesticides) having less or no hazardous effects on environment can be incorporated in pest management of forest plants.

Email: skghosh1969@gmail.com

Pesticides used in the production of non-timber species and safety of organisms and environment

Chen Wenchong, Zeng Yanru
Zhejiang A & F University

Intensive management plays an important role in the production of non-timber species, in which application of pesticides to monoculture of a large area is inevitable. For the production of many non-timber species in China, SOPs (standard operation procedures) have been developed. 29 national, provincial and local SOPs regarding *Ginkgo biloba*, *Carya cathayensis*, *Camellia oleifera*, *Myrica rubra*, *Torreya grandi* ‘Merrillii’, *Castaneamollissima*, *Castanea henryi* and bamboos including *Dendrocalamopsis oldhami*, *Phyllostachys heterocycla* cv. *Pubescens*, *Phyllostachys praecox*, *etc.* were examined against the WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification (2009) and the Globally Harmonized System of Classification and Labeling of Chemicals (ST/SC/AC.10/30/Rev. 4, 2011) in terms of pesticides suggested for use. Among the 60 pesticides listed in the SOPs, three pesticides were identified in the category of Ib, 16 in Category II and 10 in Category III, which, to a various extent, had potentially negative effects on organisms and environment. It is suggested to develop efficient pesticides with a low toxicity, and to strengthen individualized application and management of pesticide, selective breeding of cultivars with a strong resistance to pests and diseases, training of pesticide dealers, technicians and farmers, and government supervision and monitoring.

Email: yrzeng@zafu.edu.cn

Control experiments against the invasive Black Cherry (Prunus serotina EHRH.)

Viktória Erzsébet Nemes, Miklós Molnár, Dénes Bartha
University of West Hungary

The most important reasons of the global and European biodiversity loss is the biological invasion and climate change. The newcomer species can conquer the native vegetation and the allelochemicals released by invasive plants could be served as further benefit. In the Hungarian forestry one of the most dangerous invasive woody plant species is the black cherry (*Prunus serotina*). Large, unmixed populations are growing especially in the sandy lowland areas. Its first occurrence was detected in 1897 in Hungary, from 1970s start to spread explosively and settled in not planted areas as well. Further spread is still in progress.

Our study was located in two forest subcompartments in Hungary, in 2012-2013. We applied 8 different herbicide and herbicide combinations by injection, lubricating and spraying *Prunus serotina,* in 26 plots. In trunk lubrication, each *Prunus serotina* individuals with 30 cm stem length have been treated. We applied 0.2-0.4 litre product for each plant depending on the trunk diameter. During injection, only specimens over 5 cm diameter were treated. The examination was performed during the forest restoration, by sprout spraying hydraulic knapsack sprayers was used. The effectiveness was evaluated visually; when treated plants withered and did not develop new shoots, the treatments have been considered successful.

After spraying neither stool-shoot nor withered or new sprouts weren't observed. Except two plots, where in the same plots the shoots withered and new, powerful sprouts appeared. Phytotoxicity was not observed in the whole plots. The effect of lubrication experiment was not positive, the drying was less and slower on treated plots. Phytotoxicity was not observed in this plot either. The specific injected plots showed better results than lubrication plots, except two cases. Otherwise sprouts in all of the rest examined plots were heavily drying. Phytotoxicity was appeared on two working plots.

The injection and spraying were more successful control methods than lubricating as result of our study.

Email: 134 viikii1991@gmail.com

Botryosphaeriaceae associated with Acacia erioloba (camel thorn) die-off in South Africa

Draginja Pavlic-Zupanc

Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Faculty of Natural and Agricultural Sciences, University of Pretoria, Private Bag X20, Pretoria, 0028, South Africa

Acacia erioloba (camel thorn) is a native tree species distributed in the semi-arid areas of Southern Africa. In South Africa it occurs predominantly in the northern parts of the Northern Cape, North West and Limpopo Provinces, extending into a few locations of Gauteng, the Free State and Mpumalanga. Since the early 1980s, there have been reports of camel thorn die-offs in the Kathu area of the Northern Cape. A preliminary survey of the biotic factors associated with tree die-off showed the occurrence of fungal species in the Botryosphaeriaceae. These fungi are common endophytes and latent pathogens on a variety of trees worldwide. The aim of this study was to identify and characterise Botryosphaeriaceae species associated with *A. erioloba* acrossits native distribution in the Kathu area of the Northern Cape, and to compare them with the species found on *A. erioloba* trees in the Free State and the Limpopo Provinces. Samples were collected from ten trees at nine selected sites, and isolations were made from diseased and asymptomatic twigs. Isolates resembling Botryosphaeriaceae were induced to sporulate in culture and produced dark brown conidia resembling *Dothiorella* and *Sphaeropsis* species. They were subsequently identified based on ITS rDNA, LSU and β-tubulin sequences. Three phylogenetically distinct groups were recognized, two of which were linked to known species, *Dothiorella capri-amissi* and *D. sarmentorum*. The majority of isolates formed a distinct clade and appears to represent a new *Sphaeropsis* species. The new species was associated with diseased wood tissues collected across all areas sampled. This is the first record of *D. sarmentorum* on *Acacia erioloba* extending the host range for this species.

Email: pavlicdr@gmail.com

A preliminary study of Venturia

Zhang Ying , Zhang Jiaqi
Institute of Microbiology, PO Box 61, Beijing Forestry University, Beijing 100083, PR China

Species of *Venturia* De Not are widely distributed in northern temperate area of the world, which are saprobic or parasitic on a large variety of dicotyledonous plants.*Venturia* comprises 198 speciesaccording to Index Fungorum (2016). So far, the type specimens of 88 venturiaceous species have been located in nineteen herbaria, i.e. BPI, CPU, DAOM, DAVFP, E, GAM, HBG, HMAS, K, MASS, MICH, NY, NYS, PAD, PDD, PPMH, STR, W, ZT. Two hundred and three specimens of 61 species of *Venturia* have been loaned from CUP, HMAS, K, MICH, NY, NYS, PDD, PPMH, W, ZT. Of which 79 specimens are types of 54 species. All the loaned specimens, especially the types were described and illustrated. Based on the morphology of type specimens studied, the diagnosing characteristics of *Venturia* has been summarized, i.e. 1) *Ascomata*immersed, semi-immersed or superficial,scattered or gregarious, often papillateand ostiolate with setae; 2) *Hamathecium* narrowly cellular,hyaline, evanescent in mature ascomata; 3) *Asci*8-spored, bitunicate, fissitunicate, broadly cylindrical to obclavate, usually lacking a pedicel; 4) *Ascospores*paleolivaceous to brown, 1-septate, usually asymmetrical. Based on the above characteristics, six species should be excluded from*Venturia*, *viz. V*. *corni*, *V*. *crataegi*, *V*. *carpophila*, *V*. *musae*, *V*. *pruni* and *V*. *rhois*. In addition, as DNA barcoding sequences from the type specimens play a key role for the DNA barcoding program of *Venturia*. We are trying to extract DNA from the type specimens to fulfill this issue. The major difficulties we met for the type study of *Ventria* are its mini-sized ascomata, the longtime storage, as well as the scanty of ascomataon some type specimens, which sometimes makes it difficult to get enough morphological information. Some fresh specimens of *Venturia*spp., including 4 new specieshave been collected from China, i.e. *V*. *chinensis*(from *Lonicera praeflorens*); *Venturia* sp.1 (from *Populus canadensis*); *Venturia* sp2 and *Venturia* sp3 (from *Salix* sp.).

Email: yinghku@gmail.com

Invasion history of Leptocybe species reveals the complexity of biological invasions

GudrunDittrich-Schroder[1],Brett P Hurley[1],Michael J Wingfield[1,2],
SimonLawson[3],Helen Nahrung[3],Bernard Slippers[2]
1. Department of Zoology and Entomology, Forestry and Agricultural Biotechnology Institute, University of Pretoria, Pretoria, 0002, South Africa
2. Department of Genetics, Forestry and Agricultural Biotechnology Institute, University of Pretoria, Pretoria, 0002, South Africa
3. Forest Industries Research Centre,
The University of the Sunshine Coast, Queensland, Australia

The blue gum chalcid *Leptocybe invasa* (Hymenoptera: Eulophidae) has spread to all areas where *Eucalyptus* spp. are planted in less than a decade. To understand the global patterns and rate of movement of the pest, the genetic diversity within and between populations was characterised using the cytochrome oxidase I (COI) region of the mitochondrial DNA, as well as simple sequence repeat (SSR) markers. A total of 479 *Leptocybe* specimens from 18 countries and five continents were included in this study. Twenty-six COI haplotypes were identified, three of which were found in the invaded range. Mitochondrial DNA revealed the presence of three cryptic species, of which two occur throughout the invaded range and the third was found exclusively in the area of origin (Australia). Two distinct lineages (Lineage A and B) have been independently introduced into different parts of the world. Lineage A occurs in Europe, the Middle East, South America, most of Africa and parts of Asia, whereas Lineage B occurs predominantly in Asia, but also in Africa. Analyses of SSR markers supported the distinction of the two lineages and indicated the presence of admixture in the Laos population. These findings highlight the complexity of biological invasions. They also show how the admixture of two lineages has implications for effective management efforts. Furthermore, the study highlights the fact that current quarantine measures are inadequate to halt the movement of plantation pests.

Email: gudrun.dittrich@fabi.up.ac.za

Genetic analysis and rapid detection of Lymantria dispar asiatica and its related species

Wu Ying, Zhao Jie, Shi Juan
Beijing Key Laboratory for Forest Pest Control, Beijing Forestry University

Asian Gypsy moth, *Lymantria dispar asiatica*, is a worldwide forest defoliator. The false reports were frequent occurrence on Asian gypsy moth because of morphological similarity between Asian Gypsy moth and its related species. Asian gypsy moth and two related species: *L. monacha* and *L. xylina* were used in this study. Genetic diversity was calculated with ISSR technique and mitochondrial DNA (mtDNA) gene Cox1 sequences; four mtDNA sequences were used in rapid identification. The results were as follows:

4 primer pairs for mitochondrial DNA were screened from 70 conserved primer pairs, and the sequences of three species were obtained. Based on these sequences, 10 specific primer pairs were designed and screened, which 3 specific primer pairs were designed for *L. dispar asiatica*, 4 specific primer pairs were designed for *L. monacha*, and 3 specific primer pairs were designed for *L. xylina*. The optimal annealing temperature and minimum detection limits of 10 specific primers were obtained.

The reaction conditions and reaction program of ISSR-PCR were optimized, 7 primers were screened from 106 ISSR primers which produced reproductive bands. The genetic diversity and the genetic distance was calculated by POPGENE32. Clustering analysis using UPGMA method showed that geographic populations of the same species were clustered into the same group; *L. monacha* was clustered initial with *L. xylina*, and finally *L. dispar asiatica* was clustered with *L. xylina* and *L. monacha*. Phylogenetic trees constructed by neighbor-join and UPGMA method respectively based on Cox1 gene sequence showed *L. dispar asiatica* was clustered initial with *L. xylina*, and finally *L. monacha* was clustered with *L. xylina* and *L. dispar asiatica*.

Email: wylidia@gmail.com

Responses of boreal carabid beetle assemblages to variable retention harvest

Wu Linhao , John Spence, Jaime Pinzon, Colin Bergeron
Department of Renewable Resources, University of Alberta, 442 Earth Sciences Building Edmonton, AB T6G 2E3, Canada

Carabid beetles are widely used as bioindicator to evaluate response of biodiversity to disturbance. Using un-harvested stands as controls, we examined the temporal (pre-harvest to 10 years post-harvest) effects of increasing retention harvest intensities (clear-cut, 10, 20, 50, and 75%) on carabid beetle assemblages in four cover types of boreal mixedwood forests in the EMEND (Ecosystem Management Emulating Natural Disturbance) experiment in NW Alberta, Canada. Results from the first 10 years show greater temporal fluctuations of species in the harvested sites than the control sites. Dominant species changed substantially over time in retention harvest sites but remained more stable in clear-cuts and controls. Stands with higher retention level are more similar in species composition to controls. Carabid species composition in the two deciduous cover types 10 years after harvest started converging towards pre-harvest condition. However, carabid species composition in mixed and conifer dominated cover types, kept moving further away from that of pre-harvest. Differences in β-diversity between harvested stands and controls were mostly driven by species lost in early post-harvest stage and then gradually shifted to being a function of species replacement in later post-harvest stages. Long term study of carabids dynamics in response to harvest is beneficial to improve conservation of biodiversity and sustainable forest management.

Email: linhao1@ualberta.ca

The Leptographium procerum complex: global diversity, phylogeny and taxonomy

Yin Mingliang[1,2],Tuan A.Duong[3],Michael J.Wingfield[2], Zhou Xudong[2],Z. WilhelmDe Beer[2]
1. Guangdong Institute of Microbiology, Guangzhou, Guangdong Province, China
2. Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, South Africa
3. Department of Genetics, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, South Africa

Leptographium procerum (Ophiostomatales, Ascomycota) is a bark beetle-associated, root-infesting fungus on *Pinus* spp. In recent years, this fungus has gained notoriety due to its association with large-scale mortality of pines in China, where it is vectored by *Dendroctonus valens*. Several species, closely related to *L. procerum* have been described during the past decade and this has complicated the taxonomy of the group. The aim of this study was thus to reevaluate the species boundaries in the *L. procerum* complex using multigene phylogenetic analyses and morphological comparisons. A seven-gene phylogeny (ITS2-LSU, ACT, BT, CAL, TEF-1α, MAT 1-1-3 and MAT 1-2-1) including 33 isolates previously identified as *L. procerum,* together with all previously described species in this groups, revealed nine distinct species. These include *L. procerum*, *L. bhutanense*, *L. gracile*, *L. profanum*, *L. pini-densiflorae*, *L. sibiricum*, *L. sinoprocerum,* as well as two new species from China and Japan. The results also showed that *L. latens* is a synonym of *L. gracile*. Because there is no living culture associated with the holotype of *L. procerum,* and epitype has been designated for this fundamentally important species. Although sequences for the mating genes suggest that all species in the *L. procerum* complex are heterothallic, a sexual state could not be induced to form for any of the species. Given that six of the nine species are from Southeast Asia, it is possible that this area represents the centre of diversity for the *L. procerum* complex.

Email: 591063008@qq.com

Host specificity in woodwasp - fungal mutualism: Japanese siricids and their Amylostereum symbionts as a case study

Katrin Fitza[1],Masanobu Tabata[2],Natsumi Kanzaki[3],Kouki Kimura[4],
Jeff Garnas[1],Michael Wingfield[1],Bernard Slippers[1]
1. Forestry and Agricultural Biotechnology Institute, University of Pretoria, South Africa
2. Forestry & Forest Products Research Institute, Tohoku Research Center, Japan
3. Forestry & Forest Products Research Institute, 1 Matsunosato, Tsukuba, Ibaraki, Japan
4. Institute of Forestry, Aomori Prefectural Industrial Technology Research Center, Japan

It has long been assumed that the mutualism between siricid woodwasps and their *Amylostereum* fungal symbionts is species-specific. This assumption has recently been challenged in North America where the introduced *Sirex noctilio* are clearly swapping symbionts with native siricids. It is not clear, however, how common this phenomenon is amongst siricids, or whether it is specific to the invasion in North America. In this study we show that native Japanese *Sirex nitobei* is associated with both *A. areolatum* and *A. chailletii*, and not only *A. areolatum* as previously assumed. Similarly, a *Urocerus* sp.unexpectedly carried *A. chailletii*, rather than *A. laevigatum* as expected. We also show extensive clonality amongst these *A. areolatum* and *A. chailletii* populations sampled, reflecting their clonal spread by the siricids. These results support the growing realization of the lack of insect-fungal fidelity in the Siricid-*Amylostereum* association. Together with other studies the data also show that the host tree has a strong influence on *Amylostereum* species occurrence, apparently more so than wasps in some cases.

Email: fitza@lantic.net

Some new taxa and new records of Helotiaceae in China

Ren Fei[1],Zhuang Wenying[2]
1. Chiese Academy of Forestry，Experimental Centre of Forestry in north China
2. Chiese Academy of Sciences，Institute of Microbiology

Helotiaceae includes a group of ascomycetes which are saprophytic, plant parasitic or growed on other fungi.They play a important role in plant decomposition in the nature material cycle.Some species can produce pigment or compounds with antimicrobial and cytotoxic activity, others can cause plant diseases, or may degrade pollutants.

Collections from China were studied and three new species, *Chloroscypha xinjiangensis*, *Encoeliopsis multiseptata* and*Neobulgaria henanensis*, a new variety, *Tympanis laricina* var. *parviascigera,* and two new Chinese records, *Ascocalyx abietis and Crumenulopsis lacrimiformis,* are described and illustrated. Three fungi new to Helotiaceae are also described and illustrated to show species diversity of the groups, which belong to the genera *Chlorencoelia*, *Strossmayeria* and *Velutarina* and remain un-named due to materials too scanty to serve as a type. *Chloroscypha xinjiangensis* is characterized by apothecia cupulate to somewhat turbinate; asci J□ in Melzer's reagent, 47□57 × 9□13 μm; ascospores ellipsoid to broad ellipsoid, 9□13 × 6□7.5 μm. *Encoeliopsis multiseptata* is featured by apothecia discoid to somewhat urceolate; asci J□ in Melzer's reagent; ascospores long fusiform, multiseptate, 29□55 × 5.8□7.5 μm. *Neobulgaria henanensis* possesses shallow discoid, flat to somewhat convex apothecia; clavate

to cylindric asci which are 8-spored, J + in Melzer's reagent, and 64□73 × 5□6 μm; and ellipsoid, nonseptate ascospores 5.5□7.5×2.5□4 μm.

Email: feifei3080@163.com

Species diversity and invasiveness study of fungal associates of Tomicus species in southwestern China

Chen Peng[1],Ye Hui[2],Wang Xiaowei[1],Pan Yue[2],Lv Jun[2]
1. Forest Protection Institute, Yunnan Academy of Forestry, Kunming 650201, China
2. Laboratory of Biological Invasion and Transboundary Ecosecurity,
Yunnan University, Kunming 650091, China

Pine shoot beetles,*Tomicus yunnanensis*, *T. minor*, *T. brevipilosus*, and *T. armandii*, have been causing serious damage to pine trees, especially *Pinus yunnanensis* in southwestern China. However, fungal associates of four *Tomicus* species have not been elucidated. In the present study, six fungal associates of above four *Tomicus* species are recognized based on comparisons of sequence data for three gene regions (β-Tubulin, EF-1α and ITS) as well as morphological characteristics. The six taxa are described as *Ophiostoma canum*, *O. ips*, *O. abietinum*, *Leptographium manifestum*, *L. conjunctum* and *L. yunnanensis*. *T. yunnanensis*, *T. minor* and *T.brevipilosus* carry *Ophiostoma* fungi; *T. armandii* carry *Leptographium* fungi. To fungal carrying rate, *T. yunnanensis* is higher than other three species; larva is higher than pupae and new adult, no differences among heads, legs and wings of adults. Levels of pathogenic indicators of treatments with six fungi: phloem reaction zone size, compositions and contents of terpenes and phenolic acids of phloem, are significantly higher than blank control, and no differences between six fungi. *T. yunnanensis* and *O. canum* were selected to test synergy attack ability to pine trees, the results show that destructive levels are *Tomicus* with the fungi >*Tomicus* alone > fungi alone. The study provides basic information for revealing disaster mechanism of *Tomicus*.

Email: 13099919112@163.com

Taxonomy of Helotiaceae (Helotiales, Leotiomycetes) from China and phylogeny of some taxa

Ren Fei [1], Zhuang Wenying [2]
1. Chiese Academy of Forestry，Experimental Centre of Forestry in north China
2. Chiese Academy of Sciences，Institute of Microbiology

Helotiaceae belongs to Ascomycota, Leotiomycetes, Helotiales. It includes a group of ascomycetes which are saprophytic, plant parasitic or growed on other fungi. They play a very important role in plant decomposition in the nature material cycle. Some species can produce pigment or compounds with antimicrobial and cytotoxic activity, others can cause plant diseases, or may be associated with degradation of pollutants.

Based on the resources investigation and collection, more than 300 specimens from 26 provinces were examined. 37 genera were identified, 55 species, 2 subspecies and 1 variety of 27 genera were Helotiaceae. A new genus, Sinocalloriopsis F. Ren & W.Y. Zhuang was found. 13 new species were described (Chloroscypha xinjiangensis, Encoeliopsis multiseptata, Neobulgaria henanensis et al.), 5 new Chinese record genera (Ascocalyx, Cenangiopsis, Encoeliopsis et al.), and 7 new Chinese record species (Ascocalyx abietis, Bisporella iodocyanescens, Crumenulopsis lacrimiformia et al.) were discovered. A total of 69 species of 37 genera are recorded and illustrated. Keys to the known taxa from China are provided.

Based on analyses of 18S rDNA, 28S rDNA and MCM7 sequences, phylogenetic relationships among some taxa of Helotiaceae were investigated. The results show that the tested genera are not clustered together, Helotiaceae may not be monophyletic group. Different species of the same genus show high similarity and cluster together to form a separate branch, indicates that the concept of the genus is relatively clear.

Email: feifei3080@163.com

Re-translocation of leaf elements of deciduous tree seedlings in different soil condition under free-air O_3 enrichment

Shi Cong[1], Meng Fankang[2], Toshihiro Watanabe[1], Fuyuki Satoh[3], Takayoshi Koike[1]
1. Hokkaido University
2. Nankai University
3. Hokkaido University Forests

Retranslocation is the amount of an element depleted from aged plant components and provides for new growth. As leaf senescence is usually accelerated at elevated O_3 (eO_3) and leaf shedding is also influenced by soil nutrient availability, we focused on the net retranslocation and allocation dynamics of foliar nutrients to discuss the eO_3 effects on seedlings of birch, oak, beech in relation to different soil conditions via retranslocation traits.

Three species seedlings were planted in a free-air eO_3 under 3 soil types (brown forest × serpentine × volcanic ash). All species were grown under 3 replications per each plot at elevated O_3 (80ppb) and ambient condition (25-35ppb). Upper leaves in growing season (mid-September) and senescence leaves samples in mid-November were collected for chemical analysis.

Although retranslocation rate of P was markedly increased by eO_3 in birch as well as nutrient retranslocation of oak was effected by O_3 and soil, the results were appeared that retranslocation was more efficient to either eO_3 or soils for nutrients of beech.

We may conclude that beech as the representative of determinate shoot growth species might be an index species for investigating the nutrients retranslocation system in field survey since its high sensitivity to both O_3 and soils.

Email: cshi1@for.agr.hokudai.ac.jp

Studies on the mycoflora of pinus sylvestris var. mongolica infected by the sirex woodwasp, sirex noctilio (Hymenoptera: Siricidae)

Wang Lixiang, Ren Lili, You Chongjuan, Zhou Feng, Shi Juan, Luo Youqing
Beijing Key Laboratory for Forest Pest Control, Beijing Forestry University

Sirex noctilio Fabr. (Hymenoptera: Siricidae) , as one of important quarantine pest, is native to Europe and North Africa and now has spread all over the world. This species caused enormous economic losses by damaging *Pinus* species. The sirex wasp was first detected in the northeast region of China in August, 2013. Up to the present, it has colonized 17 cities/counties in China, and mostly affected weak *Pinus sylvestris* var*. mongolica*. After the invasion of pine trees swarm, the diversity of mycoflora in host trees, the relationship among host trees, *S. noctilio* and its symbiotic fungi, the differences in mycoflora diversity comparing to healthy pine were investigated. We classified the studied *P. sylvestris* var. *mongolica* into three health levels: health, weak and dead, and collected samples from the different height of the trunks: top, middle and bottom. We isolated 39 species of inner habiting fungi belonging to 25 genera. Twenty-five species were isolated from the weak pines, and most of them were pathogenic fungus and saprophyte fungus ; thirteen species were isolated from the dead pines and most of them were saprophyte fungus. The advantage fungi genera were *Chaetomium globosum, Sphaeropsis sapinea, Trichoderma* sp*., Aspergillus niger, Alternaria* sp*., Ophiostoma minus, Leptographium procerrum, Graphibum* sp*.* and *Fusarium solani.* The research results showed that the isolated fungi number presented on trends: dead> weakened > healthy trees; the species: weakened > healthy > dead trees. Regarding the whole pine stand, the top trunks tended to have most inner habiting fungi; the middle trunks had the least abundance. various number or species of fungi would found in different health levels and height of trunks of *P. sylvestris* var. *mongolica.Amylosereum areolatum* which is symbiotic fungi of *S. noctilio* were also found in the top of weakened *P. sylvestris* var. *mongolica*. The results will provide theory for *S*. *noctilio*host selection mechanism from the microscopic view.

Email: wanglx1991@hotmail.com

Factors affecting aerosol radiative forcing

Wang Jingxu, Lin Jintai
Peking University

Rapid industrial and economic growth has meanta large amount of aerosols in the atmosphere with strong radiative forcing (RF) upon the climate system. Over parts of the globe, the negative forcing of aerosols has overcompensated for the positive forcing of greenhouse gases. Aerosol RF is determined by emissionsand various chemical-transport-radiative processes in the atmosphere, a multi-factor problem whose individual contributors have not been well quantified.
In this study, we analyze the major factors affecting RF of secondary inorganic aerosols (SIOAs, including sulfate, nitrate and ammonium), primary organic aerosol (POA), and black carbon (BC). We analyze the RFof aerosols produced by 11 major regions across the globe, including but not limited to East Asia, Southeast Asia, South Asia, North America, and Western Europe. Factors analyzed include population size, per capita gross domestic production (GDP), emission intensity (i.e., emissionsper unit GDP), chemical efficiency (i.e., mass per unit emissions) and radiative efficiency (i.e., RF per unit mass).

We find thatamong the 11 regions, East Asia produces the largest emissions and aerosol RF, due to relatively high emission intensity and a tremendous population size.South Asia produce the second largest RF of SIOA and BC and the highest RF of POA, in part due to its highest chemical efficiencyamong all regions. Although Southeast Asia also has large emissions, its aerosol RF is alleviated by its lowest chemical efficiency.The chemical efficiency and radiative efficiency of BC produced by the Middle East–North Africa are the highest across the regions, whereas its RF is loweredbyasmall per capita GDP. Both North America and Western Europe have low emission intensity, compensating for the effects on RF of large population sizes and per capita GDP.

There has been a momentum to transfer industries to Southeast Asia and South Asia, and such transition is expected to continue in the coming years. The resulting relocation of emissions would meant drastic changes in both the spatial distribution and the magnitude of RF, with consequences on regional and global climate forcing. Our findings are relevant to global aerosol control and climate mitigation.

Email: 549254472@qq.com

Additions on the genus Lasiodiplodia (Botryosphaeriaceae) from China

Dou Zhipeng
Institute of Microbiology, PO Box 61, Beijing Forestry University, Beijing 100083, PR China

In the course of an ongoing survey of the biodiversity of fungal species in the Botryosphaeriaceae in China, 37 isolates with general characteristics of the genus *Lasiodiplodia* was obtained from various hosts in the southern and central parts of China. Based on the combined ITS, TEF1-α and β-tubulin sequences as well as morphological characteristics, 13 species were identified. Of these, eight species are new to science, and four species represent new records for China. In this study, we described and illustrated these eight new species of *Lasiodiplodia*, and their geographic distribution, host spectrum and phylogenetic relationships with other species of *Lasiodiplodia* are also documented. The broad host spectrum of *Lasiodiplodia* may indicate their high potential threat.

Email: yinghku@gmail.com

Division 8

Effects of experimental soil warming and drought on soil respiration and its components in warm temperate forest and subtropical plantations

Liu Shirong[1], Wang Hui[1], Liu Yanchun[1,2], Wang Yi[1]
1. Key Laboratory of Forest Ecology and Environment, China's State Forestry Administration, Research Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry
2. College of Life Science, Henan Key Laboratory of Plant Stress Biology, Henan University

Climate warming and changing precipitation regimes have been suggested to be major drivers regulating terrestrial ecosystem carbon (C) sequestration. An altered ecosystem C cycle may exhibit a positive or negative feedback to global climate change. More accurate projections of future C cycling require a better understanding of the responses of soil respiration and C sequestration to climate change. A key part of the uncertainty in terrestrial feedbacks on climate warming and drought is how soil respiration and soil C storage respond to climate warming and

drought, and which factors regulate this process. To examine the response of soil respiration and its components to climate warming and drought, we conducted a field manipulative experiment with soil warming and experimental drought in a warm temperate *Quercus aliena* forest in Baotianman Forest Ecology Station, Central China. Soil temperature was elevated by 1.23-1.66 °C using infrared heaters, and throughfall was excluded by 50% through roof installation. Soil warming substantially elevated soil respiration by 32.0–46.3 % and autotrophic respiration by 57.8–63.2 % under ambient precipitation, but reduced them under throughfall exclusion, which indicates that climate warming and precipitation reduction may stimulate soil CO_2 emission but the stimulation may not be significant if climate warming happens simultaneously with precipitation reduction. Another experimental soil warming experiment using infrared heaters was carried out in a subtropical *Castanopsis hystrix* plantation in Youyiguan Forest Station, South China. Soil warming significantly increased soil heterotrophic respiration whereas decreased soil autotrophic respiration. The response of soil respiration to soil warming is probably due to the warming induced changes in soil water. Our findings suggest that the response and potential mechanisms of soil CO_2 emission to climate warming and water fluctuation is varied with regions and forest types.

Email: liusr@caf.ac.cn

Biochar-soil interactions drive the priming of soil organic carbon and the microorganism response

Ge Xiaogai
Chinese Academy of Forestry

Recent studies have showed that biochar by artificially adding is one reliable way to reduce atmospheric carbon dioxide concentrations, indicating stable biochar changs the soil aggregate structure, water absorption and microbial activity to change natural soil organic carbon short-term turnover by the priming effect. However, there is a knowledge gap on biochar-soil interaction driving the priming effects on soil organic carbon and microorganism response under field conditions. We measured soil respiration, soil microbial community structure, soil total organic carbon and soil nutrients in a field experiment on *Phyllostachys heterocycla* forest for 14 months of no (CK), 5 (LB), 10 (MB) and 15 t biochar ha^{-1} yr^{-1} (HB) applied. The results conclusively showed that soil respiration was lower in biochar amended soil with the negative priming, especially in growing season. Compared with the control, biochar application significantly soil respiration decreased 7.34 to 41.26%, increased soil water content (1.58 %-26%), improved soil organic matter, soil total nitrogen content and soil ammonium nitrogen content and changed extraction of phospholipid fatty acids from soil, compared to the CK treatment, suggesting that biochar induced environment change for microorganisms in growing season. Biochar amendments may change environmental conditions for microbial growth with the fluctuations in C dynamics.

Email: gexiaogai2006@163.com

Effect of land use and land cover change on earthworm communities in Hong Kong

Man Suet Michelle Law, Yuk Fo, Derrick Lai
Department of Geography and Resource Management, The Chinese University of Hong Kong

Earthworms play important roles in modifying ecosystem functions and services such as the soil carbon sequestration and the soil-atmosphere exchange of greenhouse gas. However, Land use and land cover (LULC) change caused by anthropogenic activities has induced disturbances like habitat fragmentation, physical disturbances on soil, and invasion of exotic species, which could alter the earthworm communities. There is lack of knowledge about earthworm biodiversity, species composition and distribution as well as population density in Hong Kong. The study aims to evaluate the effects of LULC change on the species composition of earthworm communities in Hong Kong and how the environment of each land use/cover types relate to the community. Ecological field surveys are conducted during the wet season in 2015 and 2016 (June to October). Earthworms and soil samples are collected from four types of land use/cover (secondary forests SF, natural grasslands NG, urban parks UP and agricultural lands AL) with three replicates for each. Earthworms are sampled by the electro-octet method and identified. To examine the relationships among environmental factors, soil properties and earthworm communities, multivariate analysis such as The Analysis of Similarities (ANOSIM) method and Redundancy analysis (RDA) will be performed and significance will be discussed.

Lichens, macrofungi, carbon and nutrient pool in Palali-Mamparang mountain range, Philippines: emerging species and parameters for environmental monitoring and assessment

Crusty Tinio[1],Nelson Pampolina[1],Pastor Malabrigo, Jr.[1],Juancho Balatibat[1],Dianne Joy Aguilon[1],Paulina Bawingan[3],Janine Kaysee Soriano[6],Jennifer Niem[2],Manuel Baldovino[2],Ana Marie Carino[5],Paoul HowenVibar[1],Norvie Dela Cruz[1], RamilRodriguez[4], JasonMagdaong[7], BonifacioLabatos[7], Flores, Jovito g[7]

1. College of Forestry and Natural Resources-UPLB
2. Museum of Natural History, UPLB
3. Saint Louis University, Baguio City
4. College of Forestry, Nueva Vizcaya State University
5. Quirino State University
6. Ecosystems Research and Development Bureau
7. OceanaGold Corporation, Didipio Kasibu Nueva Vizcaya

Biodiversity resources along the Sierra Madre Mountain are among the richest ecosystem in Northeastern Luzon, Philippines where Mount Palali-Mamparang in Nueva Vizcaya and Quirino nestled. The mid-mountain forest in this area is predominated with dipterocarps and associated oaks with other myrtaceous trees. The ecosystem serves as habitat and niche to diverse group of macrofungi on forest floor being substrates and lichen hosted by trunks. Populations of both organisms were behaving variably in response to natural phenomenon and anthropogenic activities which are essential in regular monitoring and assessment of the environmental condition of the ecosystem.

The main goal of this paper to develop strategy in M and E for any developmental or industrial activities such as mining through behavioral characterization of living organisms exhibited by lichens and macrofungi. These lesser known species in the study area were recorded abundant in wet season. Their population is possibly related with soil moisture, nutrient dynamics, relative humidity, air quality, and acidity of soil and tree bark. . The result of two-year collaboration with a

mining firm would suggest that these organisms could provide vital scientific evidence to detect microclimate condition as impacted by anthropogenic and natural factors.

Email: cetinio@up.edu.ph

The Korean forest health monitoring systems: focus on the results of the first FHM

Sun Hee Kim, Joo Han Sung, Sun Mi Je, Kyong Ha Kim
National Institute of Forest Science

The health of the forest ecosystem is being exacerbated by climate changes, forest fires, unforeseen insect pests and diseases, soil acidification and so on. Accordingly, the national Forest Health Monitoring (FHM) Program was established in 2010 by Korea Forest Service to develop a national system for monitoring on the status and trends of forest ecosystem health. FHM was implemented since 2011 on a 4×4 km grid for National Forest Inventory (NFI). The plots of FHM are the 1,000 plots, 25% of NFI plots. 200 plots are selected every year, and then, it is rotated every 5 years. FHM currently monitors 32 indicators such as tree vitality, composition and structure of vegetation, and soil characteristics. This paper describes the results of the first FHM (2011~2015). In the crown vitality class, roughly 10% of the observed plots showed “the decline class” as defined by a defoliation of more than 26%. The species diversity index of canopy trees in Coastal eco-province showed the highest value?among the Korea Forest landscape and Ecosystem Zones. The average soil pH was pH 4.8±0.9.?FHM research report can be utilized by researchers as well as by policy makers to study forest ecosystems responses for long term and to monitor sustainable forest management.

Email: sands02@korea.kr

Long-term CO_2 flux monitoring over a coniferous forest in northern Kyusyu, Japan

Kenzo Kitamura, Hiroaki Hagino, Katsumi Yamanoi
Forestry and Forest Products Research Institute, Japan

Understanding the role of terrestrial ecosystems in the carbon cycle is important. In particular, forest ecosystems can absorb atmospheric CO_2 and fix carbon for long time periods. Therefore, they have an important role in the carbon cycle. We have conducted long-term CO_2 flux measurements at the Kahoku forest meteorological research site (KHW) in Kyushu Island to understand one of the forest ecosystem in Japan. This site is in a planted coniferous forest (Japanese cypress and Japanese cedar) and the most southern site of the flux network of the Forestry and Forest Products Research Institute (FFPRI-FluxNet). The averages of annual temperature and precipitation in KHW were 15.1 degree C and 2106 mm, respectively. This presentation shows inter-annual and seasonal variations in net ecosystem production (NEP), ecosystem respiration (RE) and gross primary production (GPP), and investigates the factors affecting inter-annual variation in NEP.

Email: kominy@ffpri.affrc.go.jp

Natural regeneration of targeted NTFP species: critical issue in sustainable forest management in central India

Seema Devi, Prodyut Bhattacharya
GGS Indraprastha University, Sector 16C Dwarka, New Delhi-110075

Natural regeneration performance is a key indicator of forest health and ecosystem functioning. It helps in monitoring the progress towards sustainability of local forest under the "Dry forest in Asia Process". Over the years, India has been facing serious problems of declining forest regeneration in most parts of dry zone forests. Present paper highlights the regeneration status of six targeted non-timber forest products (NTFP) species from Central India. Two years of field studies and stakeholder interactions revealed that poor soil seed bank, grazing pressure, fire, weeds and unsustainable harvesting are the leading causes of declining natural regeneration in forests. All of the targeted species were found to be under anthropogenic pressure. Due to critically low regeneration capacity, per hectare production of NTFPs has further deteriorated and some NTFP species are facing the risk of local extinction in near future**.** The government is concerned about the limited supply to herbal industries, and about the sustenance of local wild life population.In dry tropical forests, these NTFPs are important for their social value; they provide livelihood and nutritional support to forest dwellers, particularly in times of agricultural crop failure. The present study suggests policy interventions to restore the situation.

Email: seema.evs@gmail.com

Tree fine roots productivity and turnover rates estimation in alpine sandy land

Jia Zhiqing, Feng Lili
Institute of Desertification Studies, Qinghai Gonghe Desert Ecosystem Research Station, *Chinese Academy of Forestry*

Tree fine roots and their turnover rates are important to vegetation restoration and forest management. In this study, sequential coring method was used to collect the fine roots data from June to August in alpine sandy land. Turnover rates were calculated by maximum or mean biomass during the growing season in 2015 using Decision Matrix (DM) or Maximum-Minimum (MM) method. Results show that biomass in June is lower than that in July and August. Turnover rates of *Artemisia desertorum* are higher than that of *Caragana intermedia* and *Caragana Korshinskii Kom*. Turnover rates of mixed forest are higher than that of pure forest. Soil gravimetric water content is highly related to root biomass/ length in the depth of 40~60cm for *Caragana intermedia* and *Caragana Korshinskii Kom*. But soil gravimetric water content and root biomass/ length have no obvious regularity in the depth of 40~60cmfor *Artemisia desertorum*. The minimum water requirement threshold of around 0.02 can be acquired for *Caragana intermedia* and *Caragana Korshinskii Kom* in the arid region. In alpine sandy land, it is suitable to plant *Artemisia desertorum* compared to *Caragana intermedia* and *Caragana KorshinskiiKom*; mixed forest has more advantages compared to pure forest.

Email: jiazhiqing_caf@163.com

A comparison of soil properties change after the establishment of different plantation types in alpine sandy land on the Tibet Plateau

Li Qingxue, Jia Zhiqing, Feng Lili, He Lingxianzi
Chinese Academy of Forestry

Large areas of shrub plantation were established on moving sand dunes in Gonghe Basin, *Artemisia ordosica*, *Caragana korshinskii* and *Caragana intermedia* are widely used in vegetation restoration in this region. Understanding the soil qualities change after the establishment of different plantation types is important for successful soil amelioration in alpine sandy land. To assess the effects of these plantation types on the restoration of sandy land, soil physicochemical properties were measured from four depths (0–5, 5–10, 10–20 and 20–50 cm) in three plantation types and non-vegetated moving sand dunes (as a control). Relative to the moving sand dunes, there was more silt and clay content, higher total porosity and water holding capacity, more soil organic matter, total nitrogen, total phosphorus and total potassium content, less sand content and a lower bulk density in all plantation types. In plantations, soil properties were better in the surface soil (0–5 cm). Redundancy analysis and soil quality index indicated that in Gonghe Basin, *C. intermedia* has the best capacity for soil amelioration, followed by *C. korshinskii*. Our results conclude that the establishment of *A. ordosica*, *C. korshinskii* and *C. intermedia* plantations in alpine sandy land has a pronounced effect on soil amelioration, especially on surface soil, *C. intermedia* is the best choice for soil revegetation of sand dunes.

Email: lqx@caf.ac.cn

Application of a cost-benefit analysis for the economic evaluation of rockfall reduction by mountain forests

Sylvain Dupire
Université Grenoble Alpes - Irstea, UR EMGR, 2 rue de la Papeterie-BP76, F-38402 St-Marthin-dHères, France

This study presents an adaptation of the cost-benefit analysis for the evaluation of the rockfall reduction due to the presence and the management of mountain forests.

The proposed methodology combines the use of spatial data, a 3D rockfall model and a tool developed for the economical computation. The process leads to the calculation of the economical value of the protection against rockfall offered by the presence and the management of forests according to two different economical approaches: the substitute cost method and the damage cost avoided method.

This methodology was tested on six pilot areas situated in the Alps in France, Italy, and Switzerland. The results confirm the importance of forests and their specific management to face rockfall hazard, and particularly when: (1) the length of forest on the slope is important, (2) rockfall threatens a linear issue (roads, railways, etc.), or (3) issues are of low economic importance. This study also shows the relevance of the complementarity between forest and civil engineering solutions especially when threatened issues are houses and human lives. In this case, forests alone cannot ensure a sufficient protection, but its presence allows a significant reduction of the size, and consequently the cost, of additional civil engineering measures (rockfall nets or embankments).

Email: sylvain.dupire@irstea.fr

Upward distribution of subalpine conifer trees in dwarf Betula ermanii forests was inhibited by deer debarking

Takuo Nagaike
Yamanashi Forest Research Institute

In a subalpine zone of central Japan, dwarf *Betula ermanii* forests were generally located in upper of coniferous forests. Some coniferous trees (*Abies veitchii* and *A. mariesii*) could move upward by possibly climate change and have occasionally and isolatedly distributed in dwarf *B. ermanii* forests. Recently, population of *Cervus nippon* is sharply increasing and broadly distributing even in sub-alpine and alpine zone. We investigated the changes of distribution and debarking patterns of the coniferous trees in *B. ermanii* forests in central Japan. In 2008, 19 plots (10 x 40 m) were set up and trees with diameter at breast height > 3cm were identified measured their size in each plot. Debarking by *C. nippon* for each trees in the plots were also checked. In 2016, each tree was re-censured. Debarking was concentrated in the coniferous trees, and consequently most of the trees died. Therefore, the coniferous trees in the dwarf *B. ermanii* forests could eventually disappear indicated that it would be impossible to move upward of the coniferous species by climate change.

Email: nagaike-zty@pref.yamanashi.lg.jp

Impact of invasive alien weed Lantana camara on the Native Vegetation in the subtropical forests of Shivalik Hills (Northwestern India): some insights into interference mechanism

Shalinder Kaur, Daizy Batish
Panjab University

*Lantana camara*is an alien woody invasive species that has invaded several types of habitats ranging from forest areas, wastelands, grasslands and other vacant areas in Shivalik hills (Northwestern India). It quickly colonizes the given land area and forms monospecific stands replacing native vegetation and thus disrupting the ecosystem integrity. Such a quick colonization and spread suggests some interference mechanism operating at the area of its invasion. Though weed is known to be allelopathic, yet little is known about the nature and mechanism of interference and their role in suppressing native vegetation. We explored the impact of *L. camara* on species diversity, evenness and richness in invaded areas. The vegetation composition and diversity and density of native plants was significantly affected in invaded areas. *L. camara* rhizosphere soil and litter amended soil exhibited an inhibitory effect on test species. The invaded soils contained a significant amount of phenolics, the water-soluble phytotoxins implicated in allelopathy. It was further confirmed by adding activated charcoal to the soil, which resulted in amelioration of the inhibitory effect and phenolic content. The study concludes that *L. camara* adversely affects the composition of native flora, and chemical interference plays an important role in invasion.

Email: shalinderkaur@hotmail.com

Quantifying long-term forest changes and their hydrological impact using statistical and hydrological models in a large forested watershed in China

Ning Dingyuan,Zhang Mingfang,Ren Siyi
School of Resources and Environment,
University of Electronic Science and Technology of China(UESTC)

Forest change is commonly recognized as a key factor for hydrological alteration in a forested watershed. The Meijiang River basin in Jiangxi Province of China experienced long-term forest changes where forest coverage was reduced from about 40% in 1950s to about 20% in 1960s and then increased to about 70% in 2000s. This paper provided a quantitative assessment on hydrological response to long-term forest changes in the Meijing River basin through both statistical and hydrological models. The stepwise linear regression was used to quantify the relationships between selected vegetation index (NDVI and NDWI) and hydrological variables (mean flows and precipitation). It showed that both NDVI and NDWI were significantly related to monthly mean flows in a negative way, and the model with NDWI as a predictor showed better performance compared to that with NDVI. The SWAT model was further used to quantify the impact of deforestation/reforestation on mean flows, peak flows, and low flows. The result showed that deforestation increased annual mean flows, peak flows and decreased low flows while reforestation reduced annual mean flows and peak flows. However, low flows were not significantly altered by reforestation. The overall hydrological responses of deforestation was more intense than that of reforestation. This could be partly explained by delayed recovery of forest soils since soil loss after deforestation may take longer time to recover that trees. Given that the Meijiang River is one of the most important headwaters of Poyang Lake, a quantitative assessment on hydrological alteration due to long-term forest changes can provide valuable scientific evidence for both forest and water resource management in Poyang Lake basin.

Email: 1527247235@qq.com

Comparative study on the impact of climatic variability and forest disturbance on runoff in three watersheds of China

Ren Siyi, Zhang Mingfang, Ning Dingyuan
UESTC

Forest disturbance and climatic variability are commonly recognized as two major drivers influencing hydrological system in forested watersheds. Actually, separating their interactive effect in large watersheds is rarely examined. This purpose of the research is to compare the climatic variability and forest disturbance at three large watersheds in different climatic zones in China, Niyang River watershed, Minjiang watershed and Meijiang watershed, respectively. Two methods namely sensitivity-based approach and modified double mass curves were used in the research. Such statistical methods (nonparametric test and ARIMA) were used to analysis of trends and remove series autocorrelation. After that, quantitative analysis of forest disturbance and climatic variables were deduced by ARIMAX (one of the dynamic regression models). Our results show that in the Minjiang watershed, there were no changes in annual and wet season runoff. The dry season runoff attributed to climatic variables was 63.7% while forested disturbance was 36.3%. In Niyang River watershed, the annual stream flow attributed to climate was 53% while forested disturbance was 33% and 14% was by other factors. The dry stream flow attributed to climatic variability, forest and other were 39%, 46%, 14%, respectively. In Meijiang watershed, the flood season runoff attributed to climate, forest and other were 53%, 36%, 11%, respectively, while in

the noon-flood season were 60%, 30% and 10%, respectively. The study enhances us to understand the relationship of climatic variations and forest disturbance in different climatic zones.

Email: 13438175303@163.com

Using 17O to investigate the fate of atmospheric nitrate inputs to stream-water nitrate in a temperate forest catchment

Huang Shaonan
Institution of Applied Ecology, Chinese academy of science

Atmospheric nitrogen inputs stream and river ecosystems are important for various ecological and environmental concerns. Determining the fate of atmospheric N deposited to runoff nitrate in forest ecosystems is essential to understanding the ecological impact of increased anthropogenic N deposition. The $\Delta^{17}O$ of nitrate ($\Delta^{17}O_{NO3-}$) has been proved as an unambiguous tracer of atmospheric NO_3^-. In this study, $\Delta^{17}O_{NO3-}$ of precipitation and stream-water samples in a temperate forest catchment in Northeastern China were analyzed to assess the impact of nitrogen deposition to nitrate export in the forest catchment. Results showed that precipitation $\Delta^{17}O_{NO3-}$ ranged from 21.2‰ to 29.1‰ and averaged 25.8‰, stream-water $\Delta^{17}O_{NO3-}$ ranged from -0.1‰ to 3.2‰ and averaged 1.3‰. This suggested that unprocessed atmospheric nitrate (no microbial turnover) inputs accounted for 0-12% for stream-water nitrate in the forest catchment. This points to the potential importance of atmospheric N deposition to nitrogen export of forest catchment and contributes our understanding the impacts of atmospheric nitrogen deposition on forest ecosystems.

Email: huangshaonan1@gmail.com

Stem density of Chinese pine causes differences in sapwood area, transpiration and environmental responses under different soil water stress

Chen Zuosinan
School of Soil and Water Conservation, Beijing Forestry University, Beijing, China

The purpose of this research is to illuminate how stem density and soil water stress influence transpiration of Chinese pine. We measured sap flow velocity (J_z), sapwood area (A_s) and soil water content of three different stem density plot (983, 1688 and 2160 trees ha^{-1}) simultaneously with climatic monitoring in wet 2012 and dry 2014. With the increasing stem density and severer soil water stress, the J_z, transpiration and canopy conductance (G_c) decreased. Under different soil water availability, the responses of daytime transpiration to vapor pressure deficit (VPD) and solar radiation, and the sensitivity of G_c within different stem density plots behaved various. Additionally, the minimum of stand total A_s per plot area appeared in the 983 trees ha^{-1} plot. Moreover, the night-time sap flow increased with severer soil water stress and shown no significant relation with night time VPD. Increasing in light penetration, sensitivity of G_c to VPD and soil water availability leaded by lower stem density are the reason why J_z increased. In long term observation, with less competition, higher stand total As resulted by rising diameter breast height growth is another significant factor causes transpiration increased with decreasing stem density.

Email: czsn920@sina.com

A process-based rainfall interception model and its application on hillslope water balance

Li Xiang[1], Xiao Qingfu[2], Niu Jianzhi[3],SalliDymond[1], E. GregoryMcPherson[3], Natalie van Doorn[2]
1. Beijing Forestry University
2. University of California, Davis
3. USDA Forest Service, Pacific Southwest Research Station, Davis

Rainfall interception by tree crown has been a hotspot in forest hydrology, however, the role of interception in hillslope water balance remains unclear. In this study, rainfall interception was measured and modelled on a process basis with high time resolution (1 minute interval for an hour) at five rainfall intensities (10 to 150 mm h^{-1}) for broadleaf tree species *Quercus variabilis* and needle species *Pinus tabulaeformis*. Two models, including the cumulative interception during rainfall (CIDR) based on *LAI* and cumulative precipitation, $P_c: C_i = aLAI^{b}\left[1-\frac{1}{(1+mP_i)^{1/n}}\right]$ and the post-rainfall drainage (PRD) model: $C_i = \frac{1}{k}\ln(D_i+1)+cLAI^{d}$, were proposed to depict crown interception process with coefficient efficiency (*CE*) over 0.55. Afterwards the CIDR model was extrapolated to tree-covered runoff plots on hillslopes to capture the dynamic process of interception, surface runoff, and infiltration, and to quantify the relations among the three hydrological phases during rainfall. Results indicated that infiltration process was predominant in light rainfalls (< 20 mm) with total infiltration accounting for 73.5% of gross precipitation (P_g), while runoff process was dominant in heavy rainfalls (> 50 mm) since total runoff yield was 83.7% of P_g. Overall, gross water balance revealed that total infiltration was 47.0% of P_g, and total runoff was 49.6%, total interception was only 3.4% in crown-covered plots regardless of rainfall intensities and tree species.

Email: scy0418@163.com

Is plant diversity affected by early silviculture treatments after wildfire in Mediterranean forests?

Jorge De las heras
University of Castilla_La mancha.ETSIAM. Albacete. Spain

Mediterranean-type vegetation is one of the worlds major fire-prone biomes and in Mediterranean climate areas, fires influences the vegetation dynamics and structure since the early Holocene. Local diversity shows great variation within and between regions and explanations for these patterns invoke a wide range of hypotheses, although a high diversity is frequent. The role of species diversity in the functioning of ecosystems, where wildfires takes part in the dynamics, has become one of the most challenging topics in recent ecological research of many Mediterranean forests. One particular issue concerns the role of species diversity on ecosystems' ability to face extreme climate events and fire for these ecosystems. Experimental results point to a positive relationship between diversity and the resistance of the ecosystem to these disturbances. In the current study, we present biodiversity results obtained in regenerated pine forests stands after wildfire. The study sites burned the same year, in the summer of 1994 although they differ on climatic conditions. The aim of this study was to assess how early silviculture treatments affect floristic richness, diversity and life form rates or plant cover on sixteen years old post-fire Mediterranean pine stands. Results showed that diversity was affected in semiarid sites.

Email: Jorge.heras@uclm.es

Post-fire natural regeneration and resilience in Mediterranean pine forests. Implications for post-fire management

DanielMoya, JorgeDe las heras, Raquel Alfaro, ManuelLucas-Borja, PabloFerrandis, PedroPlaza, JavierSagra
University of castilla la mancha, ETSIAM, campus de Albacete, Spain

Climate change and changes in land use, modify the wildfire regimes. Resilience is the capacity of an ecosystem to resist and recovering a disturbance, in a relatively short period of time. The ecosystem resilience is function of the resistance and adaptive strategies developed by species to cope with disturbances, such as wildfires. In Southern Europe, the global change and changes in fire regime induced a decrease in productivity and plant diversity, in addition to variations in spatial distribution and vegetation structure. Those changes in fire regime could relegate large areas to secondary stages of the ecological succession. In this scenario, the adaptive forest management, including post-fire restoration, should be focused into maintain and restore ecological resilience. The recovery of vegetation was estimated by relating measurements of Normalized Difference Vegetation Index (NDVI), obtained from LANDSAT imagery, and the potential changes in floristic composition according to the time elapsed after the fire. We also calculated fire severity (dNBR). Combining both areas, we set twenty-four plots to record pine sapling density, soil coverage and diversity indices. Results showed differences in the pine resilience among sites and silviculture treatments.

Email: Jorge.heras@uclm.es

Classification and ecology of larch forest ecosystems on permafrost of norther boreal subzone of Middle Siberia

Leonid Krivobokov, Liudmila Mukhortova
V.N.Sukachev Institute of Forest, the Siberian Branch of the Russian Academy of Sciences

In order to evaluate resilience and dynamic trends of plant communities under changing environmental conditions, it needs to run an inventory of types of plant communities in global and regional scales. The objective of the study was to classify larch forests of northern boreal subzone of Middle Siberia (N 64, E 100) using the Braun-Blanquet approach. In total, four plant associations were defined belonging to *Ledo palustris-Laricion cajanderi* alliance, to *Ledo palustris-Laricetalia gmelinii* order and to *Vaccinio-Piceetea* class. Relief and climate of the studied area have a significant effect on diversity and distribution of plant associations. Plant communities of various associations can react on changing environmental conditions in many different ways. Forests of the studied area are not an important source of wood for commercial purposes, but they play very important role as soil-protecting and water-accumulating natural systems. The expansion of fires and solifluctions under the climate warming supposed to be the most destabilizing factors for the studied forest ecosystems.

Email: leo_kr@mail.ru

Forest management inspired by natural DISTurbance DYNamics (DISTDYN) – a large-scale, long-term research project

Matti Koivula[1], Timo Kuuluvainen[2], Jari Kouki[1], Risto Savolainen[3],
Juha Siitonen[4], Sauli Valkonen[4]
1. University of Eastern Finland
2. University of Helsinki, Finland
3. Metsähallitus, Finland
4. Natural Resources Institute of Finland

Forest management inspired by natural disturbance dynamics (DISTDYN) is a large-scale, long-term multidisciplinary project that was established in Finland in 2009. Our aim is to examine the role of spatial and temporal scales of harvesting in affecting forest biodiversity and regeneration, economic outcome, and aesthetic values. The motivation of the project lies in the increasing interest in using natural disturbances as a general model of forest-ecosystem management and in the recognition that relatively small-scale disturbances are characteristic for unmanaged forests in Fennoscandia. Hence the project involves a variety of logging methods. A unique aspect in the project is a comparison of ca. 150-ha landscape blocks with different dominant logging regimes (from selection and gap felling to clear felling) and harvesting intensities (as reflected by the proportion of harvested timber).

Email: matti.koivula@uef.fi

Regional cooperation on plant biodiversity conservation in response to climate change in East Asia

Ho Sang Kang[1],Miin Bang[1],Hyo Cheng Cheng[1], Jeong Ho Park[1], Hye Jin Kwon[2], In Sik Kim[2],
Cheul Ho Lee[2]
1. Seoul National University
2. Korea National Arboretum

East Asia, which shares a number of common plant species crossing the border, showed higher increase of temperature than the global average (3.5℃ over 0.85℃ from 1880 to 2012) that has aggravated the habitat shift of endemic plants and alarmed the regional level of cooperation for plant species conservation in response to climate change. Upon the MOU signing among six (6) organizations from five (5) countries in 2014, the East Asia Biodiversity Conservation Network (EABCN) has been institutionalized and conducted numerous collaborative research and data collection to develop ecological adaptation measures and establish a long-term regional conservation strategy in response to climate change in East Asia. The plant checklist in the Northeast Asia targets reviewing of plant list collected and re-arranging the scientific name and synonyms in response to the GSPC target of completion of World Flora, and plant phenological monitoring targets common and local endemic plants interacting through the website of East Asia Phenological Network. Publication targets endemic plants in East Asia which tells history, botany, ethnic use, cultural relation etc. for the public, and vegetation monitoring targets intensive and extensive long-term monitoring in a transitional zone (e.g. the zone between evergreen and deciduous one). In addition, the collaborative research on invasive plants as well as endemic plants in the DPR of Korea is in preparation.

Email: silvi@chol.com

Effects of different forest management treatments on microclimate. An experimental study

Bence Kovács[1,2], Flóra Tinya[1], Péter Ódor[1]
1. MTA Centre for Ecological Research, Institute of Ecology and Botany, Vácrátót, Hungary
2. Eötvös Loránd University, Department of Plant Systematics, Ecology and Theoretical Biology, Budapest, Hungary

Several forest dwelling organism groups are strongly influenced by stand structure and forest management types. The different structural elements primarily affect through microclimatic variables. The moderating effect of forest canopy on microclimate is essential for these taxa, thus it is important to study to what extent could forestry practices alter the below-canopy microclimate.In a mature sessile oak – hornbeam forest in Hungary, five treatments (preparation cutting, gap, micro clear-cut, retention tree group within the clear-cut, control) were carried out using six replicates in a complete block design. Light, air temperature, relative air-humidity, soil temperature and soil moisture were measured in the center of each treatments. For data analysis, 24-hour-data were collected monthly by temporally synchronized data loggers.The amount of light was largest in the clear-cut, lowest in the control plots and intermediate in the other treatments. Air and soil temperature were also highest in the clear-cuts, but retention tree groups had very similar thermal pattern. The increase of soil water content in connection of tree-removal was the highest in the gaps, while it was also detectable in the clear-cuts. Differences between treatments were more noticeable in the full leaved period. We found that groups of 10-12 retention trees appeared to be a stressed environment due to the higher thermal input and water loss by evapotranspiration. The most humid and buffered microclimate was measured in the gaps, that could help the appearance of new, light demanding species as well as the survival of species that needs continuous moderate forest environment.Gap-based management methods provide moderate forest microclimate, enhance the natural regeneration and help the survival of forest dwelling organism groups in managed forests.The study was supported by the OTKA 111887 project and the Pilisi Parkerdő Ltd.

Email: kovacs.bence@okologia.mta.hu

The effects of forestry treatments on enchytraeid worms (Annelida, Oligochaeta) in a Hungarian sessile oak-hornbeam forest.

Gergely Boros[1], Bence Kovács[1,2],Péter ódor[1]
1. MTA Centre for Ecological Research, Institute of Ecology and Botany, Vácrátót, Hungary
2. Eötvös Loránd Tudományegyetem, Department of Plant Systematics, Ecology and Theoretical Biology, Budapest, Hungary

Forest microclimate and soil conditions are essential regarding soil invertebrate communities. Enchytraeid worms (Annelida, Oligochaeta) are important decomposer organisms in forested landscapes, but very little is known about the effects of forest site conditions on their assemblages. This experiment investigates the effect of different forest management practices through forest site conditions on the abundance and diversity of enchytraeids. The following treatments were carried out in a mature temperate sessile oak – hornbeam forest using six replicates in a randomized complete block design: preparation cutting, gap creation, micro clear-cut, retention tree group within the clear-cut and control. Microclimate and soil conditions were measured in the experimental plots. It is hypothesized that applying a less intensive forest harvesting method, lower changes will be observed in this belowground decomposer community. Enchytraeid worms were monitored two times per year in the plots collecting soil samples divided to three vertical layers (0-4 cm, 4-8 cm, 8-12 cm). Each mature enchytraeid individuals were identified on species level. The field survey was carried out before (in 2014) and after (in 2015) the forestry treatments.

One year after the treatments serious decrement of abundance was found in clear-cuts and retention tree groups. The latter phenomenon means that retention groups of 10-12 trees were not able to buffer the original assemblage for these small sized Annelids. The abundance of worms decreased in the upper and middle soil layers related to drier and warmer topsoil conditions. The proportion of small geophages species (eg. Achaeta) increased, while that of bigger sized, litter consumer species (eg. Fridericia) decreased in these treatments. The study was supported by the OTKA 111887 project and the Pilisi Parkerd Ltd.

Email: boros.gergo@okologia.mta.hu

Soil respiration responses to throughfall reducation shift with interannual precipitation in a mesic warm-temperate oak forest

Lu Haibo, Liu Shirong, Wang Hui
Key Laboratory of Forest Ecology and Environment, China's State Forestry Administration, Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry

Drought is predicted to be likely more intensive and frequent in future and has huge implications on soil respiration and regional climate feedbacks. Our study is aimed to examine the effects of reduced precipitation on soil respiration (R_s) and its two components, heterotrophic respiration (R_h) and autotrophic respiration (R_a), in mesic forest at climatic transitional zone. Here, a 3 years growing season throughfall reduction(TFR, -50%) experiment was conducted in mesic warm-temperate oak forests starting in 2013. The results showed that throughfall reduction affected R_s through significantly changed R_a, but had negligible effect on R_h. Moreover, the responses to throughfall reduction shifted with interannual precipitation. In the dryer year 2014, TFR significantly stimulated R_a (+48%); but the R_a of TFR treatment were profoundly lower (-42% and -44%) than Control in wetter years 2015 and 2016. Fineroots data suggest that the contrast results were likely attributed to the changes of soil fineroots biomass and plant internal carbon allocation. Our observations imply that under the future reduced precipitation patterns, soil CO_2 emission response to drought will depend on the precipitation variation in the mesic forest ecosystem at the climatic transitional zone.

Email: luhb87@163.com

Comparison of litter water retention capacities and soil water holding capacities between *Pinus tabulaeformis* and *Quercus aliena* var. acuteserrata stands

Chen Shujun[1,2], Cao Tianjian[1], Zhang Shuoxin[1,2]
1. Northwest A&F University
2. Shaanxi Qinling National Forest Ecosystem Research Station

The capacity of litter and soil to hold water plays an important role in controlling the storage and release of water for a forested watershed. We quantified the soil physical and hydrologic properties, the litter depth, total mass for *Pinus tabulaeformis* and *Quercus aliena* var. *acuteserrata* stands, which are two of the main forest types in the Qinling Mountains. The rate of water absorption, maximum water retention capacity, and net water retention capacity of semi-decomposed layer was higher than non-decomposed layer for both vegetation types. For a given parameter, it was higher for *P. tabulaeformis* stand than for *Q. aliena* var. *acuteserrata* stand. The non-capillary water holding capacity, capillary water holding capacity, and maximum

water holding capacity of soil layer for *P. tabulaeformis* were 919.66,1667.33and 2586.98 t/hm^2, respectively, in comparison with 614.61,1416.16 and 2030.76 t/hm^2 for *Q. aliena* var. *acuteserrata* stands, respectively. Both the total litter retention capacities and soil water holding capacity for *P. tabulaeformis* stand were higher than *Q. aliena* var. *acuteserrata* stand for our study sites. To improve and sustain the growth conditions, natural regeneration and water conservation of these forests, the proper tendering and thinning measures should be considered.

Email: csfuchen@nwsuaf.edu.cn

Responses of soil buffering capacity to acid treatment in three typical subtropical forests

Jiang Jun[1], Wang Yingping[2], Yu Mengxiao[1], Li Kun[1], Shao Yijing[1], Yan Junhua[1]
1. South China Botanical Garden, Chinese Academy of Sciences
2. CSIRO Ocean and Atmosphere, Aspendale, Victoria 3195, Australia

Elevated anthropogenic acid deposition can significantly affect forest ecosystem functioning by changing soil pH, nutrient balance, and chemical leaching and so on. These effects generally differ among different forests, and the dominant mechanisms for those observed responses often vary, depending on climate, soil conditions and vegetation types. Using soil monoliths (0-40 cm) from pine forest (pioneer), coniferous and broadleaved mixed forest (transitional) and broadleaved forest (mature) in southern China, we conducted a leaching experiment with acid treatments at different pH levels (control: pH≈ 4.5; pH = 3.5; pH = 2.5). We found that pH 3.5 treatment significantly reduced dissolved organic carbon (DOC) concentrations in leachate from the pioneer forest soil. pH 2.5 treatment significantly increased concentrations of NO_3^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, Al^{3+}, Fe^{3+} and DOC in leachate from the pioneer forest soil, and also concentrations of NO_3^-, SO_4^{2-}, Mg^{2+}, Al^{3+}, Fe^{3+} and DOC in leachate from the transitional forest soil. All acid treatments had no significant effects on concentrations of these chemicals in leachate from the mature forest soil. The responses can be explained by the changes in soil pH, acid neutralizing capacity (ANC) and concentrations of Al and Fe. Our results showed that acid buffering capacity of the pioneer or transitional forest soil was lower than that of the mature forest soil. Therefore preserving mature forests in southern China is important for reducing the adverse impacts of high acid deposition on stream water quality at present and into the future.

Email: jiangjun@scib.ac.cn

Effects of simulated nitrogen deposition on root growth and phosphorus efficiency of Pinus massoniana clone in phosphorus deficiency

Song Ping[1,2,3], Zhou Zhichun [1,2,3], Zhang Rui [1,2,3]
1. Research Institute of Subtropical Forestry, Chinese Academy of Forestry
2. State Forestry Administration Engineering ResearchCenter of Masson Pine
3. Zhejiang Provincial Key Laboratory of Tree Breeding

The objective of this study was to determine the effects of simulated N deposition on root morphological characteristics and effiency P in *Pinus massoniana* under low P stress. Treatments included two P conditions, i.e. homogeneous low P availability vs. Heterogeneous low P availability among soil layers, in combination with three N deposition levels in a two-year pot experiment. Two clones of *P. massoniana* seedling with different P efficiency were used. The results indicate that: 1) Simulated N deposition affected seedling growth, along with significant interactive effects among N supply level, P condition and genotypes. The growth traits of *P. massoniana* were significantly increased by simulated N deposition. 2) N deposition significantly simulated fine root proliferation in fine-root diameter class of ≤1.5 mm, while roots with diameters ranged from 1.5 to 2.0mm and over 2.0mm weren't apparent changed in value. 3) Under the heterogeneous low P condition, seedlings in the clone 19-5 were found to respond to the simulated N deposition with increased fine root length and surface area of≤1.5mm roots in diameter. Additionally, their N and P absorption efficiency subjected to N120 were significantly enhanced at 93.30% and 148.45%, respectively. Finally, we found that fine-root(≤1.5mm) proliferation and high P absorption efficiency of *P. massoniana* maybe the adaptive mechanisms to atmospheric N deposition under P deficiency.

Email: songping_hzau@163.com

Impacts of land use change and climate variations on annual inflow into the Miyun Reservoir, Beijing, China

Zheng Jiangkun
Sichuan agricultural university

To effectively quantify the different impacts of the climate variation and land use change on inflow into the Miyun Reservoir during different sub-periods, an annual water balance model (AWB), the climate elasticity model (CEM), and a rainfall–runoff model (RRM) were employed to conduct attribution analysis synthetically. We found a significant ($p < 0.01$) decrease in annual stream flow, a signi?cant positive trend in annual potential evapotranspiration ($p < 0.01$), and an insigni?cant ($p > 0.1$) negative trend in annual precipitation during 1961–2008. We identified two stream flow breakpoints, 1983 and 1999, by the sequential Mann–Kendall test and double-mass curve. Climate variability alone did not explain the decrease in inflow?to the Miyun Reservoir. Reduction of water yield was closely related to increase in actual evapotranspiration due to the expansion of forestland and reduction in cropland and grassland. The contribution to the observed stream flow decline from land use change fell from 64–92 % during 1984–1999 to 36–58 % during 2000–2008, whereas the contribution from climate variation climbed from 8–36 % to 42–64%. Model uncertainty analysis further demonstrated that climate warming played a dominant role in stream flow reduction in the most recent decade (i.e., 2000s).

Email: jiangkunzheng@126.com

Analysis on spatial distribution characteristics of temple trees in Wutaishan Mount in CHINA

Zhang Decheng
China academy of forest

[Objective] Temple garden is an important part of the Chinese traditional garden and being tourist attraction usually. Study on spatial distribution of trees in the temple can explore the built philosophy of temple garden and provide reference and guidance for traditional temple forest building and it’s trees monitoring.

[Methods] This paper make a case study on 18 temples in Wutaishan Mountain, Shanxi Province in China. It make a investigation on trees in the temples and analysis trees coverage rate, trees covered patch size, shape, position, the relationship between trees and buildings using landscape analysis and statistical analysis method.

[Result] The results shows that (1) The main tree species are pine, elm, dragon spruce. Pine and dragon spruce spruce covered area accounted for 65% of the total area. (2) The forest tree coverage rate was 1%-30%, and the average forest coverage rate was 9%. There are 460 patches, which are about 80% close to the circular patch, the patch size between $1m^2$-$1200m^2$. (3) There are 15% of the trees close to the temple in the axis. Before and after half comparison about 42% and 58% of the temple and about half part compare the right and left to central axis of the temple. (4) the patch of trees connected with the building accounted for 75%.

[Conclusion] The dominated trees are native tree species in Wutaishan Mount temple. Trees in the temple accounted for smaller area and san distribution .and symmetry distribution from axis but species of symmetry is not strict. planting trees prefer to on both sides of the axis. Trees and buildings adjacent nearly and constitute the temple gardens remarkable view combine traditional architecture and native tree species.

Email: zdc1973@126.com

Distribution pattern of soil nematode communities along the five vertical forests on the eastern slope of Gongga Mountain

Wu Pengfei
Southwest University for Nationalities

soil faunais becoming an increasingly important objective of forest ecology. The vegetation types changed from subtropical evergreen broad-leaved forest?to coniferous forest on the eastern slope of Gongga Mountain. But the distribution patterns of soil fauna belowground are still unknown. Soil nematode communities were investigated under the subtropical evergreen broad-leaved forest (SEB), subtropical evergreen and deciduous broad-leaved mixed forest (SEDB), warm temperate deciduous broadleaved forest (WTDB), mid-temperate coniferous-broadleaved mixed forest (MTC) and cold temperate coniferous forest (CTC) along the different vertical climate zones in September and December 2014. The differences in individual density, richness, Shannon index and Pielou index were not significant among vertical forests, but significant between sampling months. The bacterivores were more abundant than the other trophic groups in all habitats. The abundances of predators-omnivores and plant parasitic increased remarkably from SEB to CTC. The basic index, channel index and maturity index of the soil nematode communities varied significantly among different habitats. The basic index value in the subtropical zone was higher than other zones, but the maturity index in the subtropical zone was lowest. The channel index showed that the bacterial decomposition is the main energy flow channel in the detrital food web.

Email: wupf@swun.cn

Potential of Phytolith -occluded organic carbon sequestration in China's bamboo forests

Jiang Peikun , Xu Qiufang , Huang Zhangting
Zhejiang A & F University

In this study, we choose 9 monopodial bamboo species and 8 sympodial bamboo species which are typical and important bamboo species in China, compare the content of Phytolith and Phytolith-occluded organic carbon (PhytOC) in different organs of different bamboo species, estimate the capacity of PhytOC storage of bamboo ecosystem in China, by using microwave digestion and Alkali Dissolution-Spectrophotometry. The result shows that the content of PhytOC in bamboo leaves is much more than that in branches or culms; the capacity of PhytOC in most monopodial bamboo species is much higher than sympodial bamboo species, and we find that *Phyllostachys glauca McClure* have the highest PhytOC storage in per unit area (82.4 kg $\cdot ha^{-1}$) especially; the PhytOC storage of aboveground in bamboo ecosystem of China is about 1.53×10^6 t-e-CO_2, which means that the bamboo system in China is a big stable potential carbon pool.

Email: jiangpeikun@zafu.edu.cn

Division 9

A review of carbon forest development in China

Zhou Wei, Gao Lan
South China Agricultural University

Based on a specific review of policy documents, trading data and investigation, this paper provides an overview of China's climate mitigation policy related to forestry sector. It shows carbon forest developed fast in China to mitigate climate change. A total of 1.97 million ha carbon forests have been planted and managed funded by government investment, social funding and carbon markets. Multiple funding sources and technical standards of carbon forests issued by SFA are main strategies in developing carbon forests. However, in future development of carbon forests under market mechanism, establishment costs, limited demands, and disputes between households and project developers will be the main challenges. These findings can do help on policy making about future carbon forest development in China.

Email: zhoueragon@foxmail.com

Rethinking of co-management of forest protected areas for improved biodiversity: a critical review from Bangladesh

Md. Shams Uddin
Winrock International

The paper reviews co-management of forest protected areas in Bangladesh including its structure, stakeholders' interest, strength, weakness, opportunities, threats and also offers policy recommendations to strengthen and expand accordingly. The paper is based on literature review, multi-stakeholders and expert consultations, published papers, government and project documents to analyze various aspects of Co-Management. The paper highlights critical concerns and a modern Co-Management structure is proposed for conserving biodiversity and ecosystem services of protected areas in Bangladesh. It is not possible to carry out controlled experiment (without Co-Management) of PAs. The paper will guide policy makers to expand and strengthen Co-Management for improved biodiversity and ecosystems management in changed environment. The paper proposes the first time inclusive Co-Management that is socially accepted, economically pro-forest dependent people, covering improved governance of biodiversity and natural resources management with sustainable long term visioning for sustainable forest protected areas management in Bangladesh.

Email: msuddin.shams@gmail.com

State forest management conflicts in the media and litigations

Mi Sun Park[1], Kwan Hee Lee[2], Dong Geun Kim[2]
1. Konkuk University
2. Kyungpook University

Multiple interests exist in managing state forests and forest conflicts among different interests have emerged. This study aims to investigate the phenomenon of state forest conflicts in the Republic of Korea (ROK). Litigation suits related to state forests were analysed using the online legal information system of the Supreme Court of Korea. The contents of the litigations were analyzed with a focus on substances and litigants (plaintiffs and defendants). The state forest conflicts represented in the print media were analysed using the (Korean Integrated News Database System). Litigation suits and media articles present actors and issues of state forest conflicts. They indicate the conflicts between public and private sectors in managing state forests. The research findings do contribute to extending our understanding of the state forest conflicts. They can be useful in establishing policies to control conflicts on state forest management.

Email: mpark@konkuk.ac.kr

Impact of payment for ecosystem services on local livelihoods --a case of the Miyun watershed management in China

Zhiying Han, Yeochang Youn
Seoul National University, College of Agriculture and Life Science

From 2006 Beijing municipal government and Hebei provincial government have proposed the policy of Paddy Land Conversion Project (PLCP) in the upstream area of the Miyun reservoir to increase the yield of downstream water supply in Beijing. In this paper, we evaluate and analyze the impact of implementation the PLCP on the local livelihood during almost 10 years. Though doing the face-to-face interviews and questionnaires to do the survey in 4 special and representative villages in different regions in the upstream area of the Miyun Reservoir. By the methods of Differences-in-Differences (DID) and Cost-Benefit Analysis (CBA) to understand households' reaction to PLCP, especially the behavioral choices, to compare the systematic differences between these households live in four areas due to different distance far from Miyun reservoir can impact DID estimators if these differences affect how households response to the project, and to provide recommendations for Payment for Ecosystem Services (PES) policy design for a more integrated approach to watershed management. The PLCP of PES also has the potential to promote economic development in upstream communities by providing additional financial resources to households and changing land use and production activities.

Email: hanzhiying@snu.ac.kr

Co-Management approach, policy and potentials of community forestry for sustainable forest conservation and benefits for livelihood, Cambodia

Sareth Nhem
Kongju National University

The study aimed to examine implication of forest policy and potentials of community forestry for forest protection and promotion of livelihoods. The co-management is dynamic foundation of solid collective rights, actions and power sharing approach for sustainable forest protection and promotion of livelihoods. The study determined co-management is modern decentralization for the mix of hybrid top-down and bottom-up central. The forest policy recognizes and respects the collective rights and full participation of local people to safeguard forest, we however argued that forest policy must strengthen its enforcement capacity, including revising complexity and creating inclusive monitoring and evaluation mechanism to address and mitigate the risk. We defined community forest plays as potential forces to serve as stock of social, environment and economic for local people and government. However, study revealed that community forestry faces critical problems to be addressed. Although, community forestry requires more technical and financial supports for self-sustaining, we also claimed that community forestry should be increasingly developed across country. We addressed to study on economic value on non-timber forest products and community forestry sites, whether it could benefit and afford the sustainable benefits to improve livelihoods as it did in the past or not at the present time.

Email: nhemsareth@gmail.com

PFES design and introducing policies on forest ecosystem services improvement related to watershed protection forests in the ROK

Chulhyun Jeon
National Institute of Forest Science

The objective of the research is to contrive measure of compensation system on forest owners through Payment for Forest Ecosystem Services (PFES, or PES) to sustainably supply forest ecosystem services (FESs) and its improvement to PFESs participants(especially buyers) with issues of additionality verification, contract, and compensation level, etc. reviewing literature of domestic and international policies related to PFES. In case of Korea both legal regulations such as non-plantation forests, protected forests, Backdu-Degan protected area and market mechanism such as National Recreation Forest System (entrance fee, using fee) and carbon offset trading system were simultaneously applied to supply FESs. However, those systems have been made systemically disadvantages about lack of compensation measure compensation level, calculation difficulties of opportunity costs, its elimination for forest owners, and finally conflicts of forest owners. With possibility of PFES system internationally applied and design of PFESs compensation system on forest water storage function in the upper stream BukHan-river with scientific verification of additionality issues, PFES system is composed of service supplier forest owners upper stream in 5 area Chuncheon, Hongcheon, Hwacheon, Yanggu, Inge area and buyers (beneficiary) downstream area 3 regional cities Seoul, Gyeunggi and Incheon, and 8 regional offices associated to PFESs. In PFES simulation questionnaire result respondents about PFES supplies (63.6%) and buyers (53%) show positive participation, and the regional officers

represent '5-years contracts most preferred'. To work PFESs 'recognition change on free services about water storage function from forests', 'appropriate level of incentive to induce forest owner participation' , 'transparent fund investment and its use' is most important implications from this research. Therefore, it proves that PFESs in Korea is an appropriate instrumental policy to mitigate flood and drought problem in responding to climate change and to sustainably improve FESs over time.

Email: ecoecon@korea.kr

Recent situation of illegal logging in production forests and protected areas in Myanmar and Cambodia

Nobuya Mizoue[1],Tual Cin Khai[2],Thein Saung[2],Zar Chin Win[1],Tetsuji Ota[1],Tsuyoshi Kajisa[1],Shigejiro Yoshida[1]
1. Kyushu University, Japan
2. Forest Department, Myanmar
3. Kagoshima University, Japan

Illegal logging is widely reported in tropics and considered the main cause of deforestation and forest degradation, but there have been a dearth of quantitative and systematic field data of its incidence and effects on stand structure. Using field measurements of stumps and time series LiDAR data, this study reveals recent situation of illegal logging in production forests and/or protected areas in Myanmar and Cambodia. In selective logged production forest of Myanmar, we showed field evidence of illegal logging occurring just after official logging operations and the logging intensity is much larger for illegal logging than legal one, resulting in strongly degraded stands with bamboo dominance. Our research team also had found illegal logging in Papa Mountain Park, one of the most famous park in Myanmar, showing relatively low tree density of small diameter classes. In Cambodia, we analyzed LiDAR data obtained 2012 and 2014 in the protection forest; within even only two years interval, we found illegal logging much more than we thought. Our recent quantitative study calls for urgent countermeasures against illegal logging and restoration of strongly degraded forests induced by illegal logging.

Email: mizouenn@gmail.com

REDD+ politics in the media: a case study from Vietnam

Thu thuy Pham[1], Monica Di Gregorio[2], Maria Brockhaus[1]
1. CIFOR
2. Sustainability Research Institute, University of Leeds

Reducing emissions from deforestation and degradation (REDD+) is an international effort to create financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from land uses. Vietnam is engaged in the international REDD+ debate and is a partner to numerous multi- and bilateral agreements. Different actors have diverse interests in the REDD+ agenda, and in Vietnam, even though an authoritarian state, different views exist on what REDD+ should achieve. Through the analysis of media articles this study intends to understand how public debates on REDD+ are framed in the Vietnamese policy domain and how actors use the media to promote their interests. Reporting about a diversity of actors and interests, in particular related to expressions of equity concerns in media frames could reflect a growing

inclusive political space. Our findings show that while state actors dominate REDD+ media frames, some limited space is present for non-state actors' interests, but equity issue discussed, unlike in other countries, still reflect predominantly state mediated concerns. However, these two key findings could indicate some prospects for the uptake of non-state actors including domestic businesses and international organisations in the Vietnamese REDD+ experiment and a move away from entirely state-controlled media, but caution is still required due to the limitations these findings come with.

Email: brissiesugar@gmail.com

Is forest contributing to the livelihoods of communities fringing bosomoa forest in Ghana? Gendered analysis using PROFOR livelihood toolkit

Mercy Derkyi[1], Nana Sarfo Agyemang Derkyi[2], Jesse Sarbeng[1]
1. Department of Forest Science, University of Energy and Natural Resources
2. Department of Energy and Environmental Engineering,
University of Energy and Natural Resources

Forest resources role in people's livelihoods and the economy of most developing countries are multifaceted. Unfortunately, contributions in terms of NTFPs and sustaining agriculture are often not quantified and not fully appreciated in policy. Using focus group discussions among 60 farmers (30 men and 30 women) in three communities, it analyses the contribution of forest resources in comparison with agriculture to the livelihoods of smallholder farmers in the transitional zone of Ghana using poverty-forests linkages livelihood toolkit. The PROFOR toolkit enables us quantified these contributions in relative percentages. The result indicates that agriculture contributes significantly to the annual livelihoods in terms of cash than forest. Nevertheless, forest contributions are significant as non-cash income in the form of firewood, water, and seasonal accessibility to NTFPs such as snails and mushroom. Furthermore, the decline of forest resources in view of deforestation, annual wildfires, and illicit farming are negatively affecting the normal farming seasons and practices. We, therefore, conclude that the synergy between forest and agriculture in terms of policy and practice are needed to redress forest degradation, low agricultural productivity, and food insecurity among communities living on the fringe of forests at this dawn of climate change.

Email: mercy.derkyi@uenr.edu.gh

Creating both conflicts and solutions between customary and legislative regulation – case of China

Dong Jiayun
Fujian Agriculture and Forestry University

With the implementation of collective forest tenure reform since 2003 in China, many collective conflicts of forest tenure sprung up, severely hindering the reform and social stability. By constructing an analytical framework of country, society and Mafia-like gangs, the paper analyzed a collective conflict about the transfer of collective forestland, and revealed the relations of check and balance. Collective farmers often have an impact on local governments through continually appeals and petitions to force them to take beneficial actions, and local governments, who were sympathy for farmers' experiences and also knew legality of transfer, usually play a role of

coordinator rather than arbitrator. When forestry investors found the local governments' rocking attitude, unofficial measures of employing the Mafia-like gangs would often be took, and local governments may tolerate the behaviors for ending the conflicts. As a result, all three parties compromised to realize steady-state equilibrium, and the conflict was resolved. The study showed that, while China was transforming from the traditional rule of rite to modern rule of laws, the development and solution of collective conflicts of forest tenure were accompanied with the integration and conflict between formal and informal institutions, legislation and custom.

Email: dsz.djy@163.com

Over regulated and under marketed:
challenges in Supporting feasible verification processes in Lao PDR.

A. Flanagan, R. Laity, B. Lattanavongkot

The plantation resources of Lao PDR, including the smallholder Teak (~20,000ha) resource, have the capacity to generate substantial benefits to growers and support a domestic industry in a globally competitive environment. ACIAR: Project FST/2012/012 "Enhancing Key Elements of the Value Chains for Plantation-Grown Wood in Lao PDR", which aims to improve livelihoods for farmers and processing workers and the international competitiveness of Lao PDR wood industries through improved efficiency of key elements of the planted wood value chain.

Small holder integration in supply chains has many benefits including that it reduces conflict, provides access to land, generates profits, improve livelihoods, supports industrial operations and are flexible and often sustainable. An analysis of voluntary verification and involuntary regulatory compliance systems that operate, or could operate, within Lao PDR was undertaken to determine "What forms of grower organisation and group certification are feasible and sustainable, and will improve returns to plantation smallholders?

Voluntary certification systems have failed to deliver cost effective market benefits to smallholders. They are complex and do not add value. Current certification systems apply a similar risk profile and compliance cost structure to smallholder plantation growers and large, industrial growers. Few smaller, private growers are able to adopt these systems, and those that do so in Laos generally receive no improved market access or price premium.

External support is been provided for certification, however, low take-up by small, farmer-scale, plantations indicates that verification or compliance requirements are too complex and costly to adopt. Where certification has been adopted, the expected increases in returns to plantation owners have not occurred.

Where certification has been implemented it has been reliant on external funding from international donors. These funding arrangements need to be put on a more sustainable basis.

Complex and inflexible measures are used by current certification systems to assess sustainability. Certification systems must simplify their requirements and demonstrate value to small holders if they are to increase the involvement of small-scale growers in markets for sustainably managed timber.

The effects of legislation on forest for the future: sustaining society and the environment in poor and rich countries

Vitalie Gulca[1,2], Robert Deal[3]
1. Forest Research and Management Institute
2. Forestry and Public Gardens Department, State Agrarian University of Moldova
3. USDA Forest Service, PNW Research Station, OR, USA

It is widely recognized that forests can provide significant contributions to poverty alleviation, rural development, biodiversity maintenance, and healthy forest ecosystems. However the area of net annual deforestation on the global level is still estimated at 7.3 million hectares per year (an area about the size of Sierra Leone). Further compounding the challenges of natural resource management, the world population has been estimated to reach 7.7 billion by 2020, with over 80% of population occurring in developing countries. Our research will assess different policy approaches that could be applied in future forests and we will evaluate both positive and negative effects of legislation and specifically compare and contrast these effects in poor and rich countries. We will develop some case study examples using both poor (e.g. Moldova) and reach (e.g. USA) counties and apply these approaches to other developing countries (e.g. India and Philippines). We will compare and contrast some of the effects of forest policy on rich and poor countries with specific suggestions to improve sustainable forest management. Finally, we develop some recurring themes and suggestions about the potential role of forest policy for future forests in both developed and in developing countries.

Email: vitalie.gulca@gmail.com

www.iufro-ao2016.org

IUFRO

CHINESE ACADEMY OF FORESTRY
中国林业科学研究院