Joint International Conference

"Biological Reactions of Forests to Climate Change and Air Pollution"

Organised by

IUFRO Research Group 7.01.00
COST Action FP 0903
ENVeurope Project
ICP Integrated Monitoring Programme
North American Air Pollution Workshop
European Long-Term Ecosystem Research Network

Abstracts & Programme

18 – 27 May, 2012
Kaunas, LITHUANIA
Aleksandras Stulginskis University

Abstracts & Programme

International Conference

"Biological Reactions of Forests to Climate Change and Air Pollution"

Jointly organized by:

IUFRO Research Group 7.01.00

"Impacts of air pollution and climate change on forest ecosystems"

COST Action FP 0903

"Climate Change and Forest Mitigation and Adaptation in a Polluted Environment"

ENVeurope Project

„Environmental quality and pressures assessment across Europe: the LTER network as an integrated and shared system for ecosystem monitoring"

ICP Itegrated Monitoring Task Force Meeting

North American Air Pollution Workshop

European Long-Term Ecosystem Research Network LTER-europe

21 – 24 May, 2012
Aleksandras Stulginskis University,
Faculty of Forestry and Ecology
Kaunas, LITHUANIA

under
USDA Forest Service International Programs support
for students and young scientists

Scientific Chairs

Algirdas Augustaitis, *Lithuania*
Andrzej Bytnerowicz, *United States*,
Elena Paoletti, *Italy*

Scientific Committee

Algirdas Augustaitis, *Lithuania*
Salim Belyazid, *Sweden*
Andrzej Bytnerowicz, *United States*
Mark Fenn, *United States*
Nancy Grulke, *United States*
Shang He, *China*
John King, *United States*
Lars Lundin, *Sweden*
Rainer Matyssek, *Germany*
Gerhard Müller-Starck, *Germany*
Elena Paoletti, *Italy*
Alessandra Pugnetti, *Italy*
Marcus Schaub, *Switzerland*
Yusuf Serengil, *Turkey*
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Sirkku Manninen
Vitas Marozas
Rainer Matyssek
Gerhard Müller-Starck
Elena Paoletti
Marcus Schaub
Yusuf Serengil

*Dear University Faculty and Students,
Dear Members of the Organizational Committee and Participants of the Conference,
Ladies and Gentlemen,*

*I send my sincere greetings and best wishes to your community which has come together to once again highlight the importance of coexistence between man and nature, to discuss environmental issues, and to identify the challenges of today and the opportunities of tomorrow.
I welcome you all and I thank you for not being indifferent to yourself, to those around you, to your country and your land.*

*I have always believed, and I continue to believe, that the culture of environmental protection and our relationship with nature is a vital part of general human culture.
Therefore, any talk about the achievements of civilization without humanitarian dimension, sense of responsibility and serious environmental analysis will never be anything more than just mere talk.
It is only careful and respectful approach to the surrounding environment, the ability to capture the full range of human economic activity, and common responsible policies that will lead us to genuine progress.*

*I am delighted that we see the same things in the same perspective and that we stand together as like-minded people and colleagues.
It is all the more pleasing that this conference on human and nature safety is held in an academic environment.
It gives hope that today's students will absorb not only professional knowledge, but will also learn lessons of responsible living and working which will help them build a sustainable relationship with nature.
It sends a message that there is a strong chance for the world of tomorrow to be humane and cultured in the broadest sense of the word.*

*Thank you all whose hard work and commitment have made it a possibility.
Thank you all who focus not only on the present, but also on future perspectives.*

*Once again, I send cordial greetings to your open and dynamic forum.
I wish you lively discussions, fruitful results and every possible success!*

President Valdas Adamkus

May 21, 2012

UNIVERSITEIT VAN PRETORIA
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Forestry and Agricultural Biotechnology Institute

Professor Algirdas Augustaitis
Faculty of Forestry
Aleksandras Stulginskis
University
Kaunas, Lithuania

4th May 2012

Dear Professor Augustaitis,

I would like to congratulate you personally as well as the faculty and administration of the Aleksandras Stulginskis University on the occasion of holding the international conference ***"Biological Reactions of Forests to Climate Change and Air Pollution"*** at your University. This conference, co-organized by the IUFRO Research Group 7.01, COST Action FP 0903, ENVeurope and the North American Air Pollution Workshop, exemplifies excellent international collaboration in forestry research which is strongly promoted and supported by IUFRO.

I sincerely believe that this event will enhance our understanding of the effects of air pollution and climate on forests and will allow for an effective exchange of ideas between the scientists, managers and decision makers aiming at the well-being of the Baltic forests as well as forests in other parts of the World.

Best wishes and sincerely,

Michael J. Wingfield (Ph.D., FRSSA, ASSAf)
IUFRO Vice President for Divisions

"Future Forests and Food"
FABI (Forestry and Agricultural Biotechnology Institute)

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IUFRO

May 4, 2012

Prof. Algirdas Augustaitis
Faculty of Forestry
Aleksandras Stulginskis University
Kaunas, Lithuania

Dear Professor Augustaitis,

I would like to thank you personally and the administration of the Aleksandras Stulginskis University for organizing at your University the international conference "Biological Reactions of Forests to Climate Change and Air Pollution".

This conference, for the first time integrating meetings of the IUFRO Research Group 7.01, COST Action FP 0903, ENVeurope, the North American Air Pollution Workshop and ICP Integrated Monitoring Task Force, is an excellent example of an effective international collaboration in the forestry research. It also confirms IUFRO's active role in promoting collaboration between the forestry scientists, managers and decision makers aiming at better understanding of biological effects of air pollution and climate with an ultimate goal of improved health, sustainability and productivity of forests in the Baltic States and worldwide.

Sincerely,

A. Bytnerowicz

Dr. Andrzej Bytnerowicz
Coordinator of IUFRO Research Group 7.01
"Impacts of Air Pollution and Climate Change on Forest Ecosystems"
Deputy Coordinator of IUFRO Division 7 "Forest Health".

Caring for the Land and Serving People

Foreword from the COST Action FP0903

COST - the acronym for European Cooperation in Science and Technology - is the oldest and widest European intergovernmental network for cooperation in research (http://www.cost.eu). Established by the Ministerial Conference in 1971, COST is presently used by the scientific communities of 36 European countries to cooperate in common research projects supported by national funds. The funds provided by COST support cooperation networks, organized as COST Actions.

Action FP0903 "Climate Change and Forest Mitigation and Adaptation in a Polluted Environment (MAFor)" (http://cost-fp0903.ipp.cnr.it/) was established in 2009 and created a platform of experts from different fields, with the following main objectives: 1) to increase understanding of state and potential of forest mitigation and adaptation to climate change in a polluted environment, and 2) to reconcile process-oriented research, long-term monitoring and applied modelling at comprehensive forest research sites, for which the concept of "Supersites" (comprehensive forest research sites) is being developed. In particular, MAFor aims at translating the existing European knowledge on climate and air pollution dynamics into impacts on forests, with focus on the carbon, ozone, nitrogen and water budgets.

Networking the research, monitoring and modelling communities working with air pollution and climate change at forest sites is a key objective of this Action. This is why the Action is very active in communication and is glad to collaborate in the scientific organisation of this major event in Kaunas. This is the first time that experts from diverse networks and projects (IUFRO Research Group 7.01.00 "Impacts of air pollution and climate change on forest ecosystems"; North American Air Pollution Workshop; ENVeurope Project "Environmental quality and pressures assessment across Europe: the LTER network as an integrated and shared system for ecosystem monitoring"; ICP Integrated Monitoring; and the COST Action FP0903) have the opportunity to meet and discuss the challenges forests are facing due to the interaction of air pollution and climate change. We are really grateful to the local organisers prof. Algirdas Augustaitis and Aleksandras Stulginkis University for welcoming us in Lithuania. We would like to thank all the colleagues who have been working to the organization of the conference, in particular Andrzej Bytnerowicz. A special mention is to Ingrida Augustaitiene, whose hard work, communication skills and continuous support have been instrumental to the success of this event.

On behalf of Action FP0903, I wish all the speakers and attendees a fruitful conference.

Elena Paoletti
Chair of Action FP0903, IPP-CNR, Via Madonna del Piano 10, 50019 Sesto Fiorentino (Florence), Italy

EnvEurope Project
Life08 ENV/IT/000399

'Environmental quality and pressures assessment across Europe: the LTER network as an integrated and shared system for ecosystem monitoring': the Life+ Project EnvEurope (2010-2013) at the IUFRO Conference

The Life+ Project 'EnvEurope' is honoured to be among the organizers, supporters and participant at the International Conference 'Biological Reactions of Forests to Climate Change and Air Pollution'. Within the Conference, the session 'Environmental Quality and Pressures Assessment under Global Changes' is specifically organized by the project in cooperation with the International Co-operative Programme ICP IM. Besides, the first 2012 EnvEurope Coordination meeting will be held in parallel sessions throughout the Conference.

EnvEurope was motivated and conceived in response to challenges of ecological research within the European site network LTER-Europe. It involves 11 (out of 22) national LTER-Europe networks and almost 70 LTER-Europe sites (out of more than 400) and it is dealing with several key aims of LTER-Europe, e.g.development of an integrated ecological data management system, contributing to the technical components of SEIS (the EU Shared Environmental Information System); identification of priority parameters and harmonized methods to be applied in the standard ecological studies; elaboration of long-term ecological data to deliver scientific information to scientists, policymakers and citizens; performing of common and harmonized field activities on shared parameters; improvement of the network design, through the evaluation of the weaknesses and strengths of the present LTER-Europe network; dissemination of the LTER mission, ecological data and knowledge about ecosystem functions and processes. The Project has also the task to contribute to GMES (Global Monitoring for Environment and Security): the LTER-Europe network, with its sites located across Europe´s biogeographical regions, can play an important role as an official validation network and in-situ data provider for the GMES ecologically meaningful products.

The joining of different initiatives, programmes and expertise at this International Conference will surely enhance scientific information exchange and collaboration, thus improving the ecological knowledge of forest ecosystems across Europe and the scientific contribution to a sustainable management of these environments. Terrestrial ecosystems and, in particular, forests are largely represented within the EnvEurope and LTER-Europe sites: most of the LTER sites are connected with the International Cooperative Programme ICP Forest. However, EnvEurope has an explicit trans-ecodomain approach: activities are developed always considering the three main ecosystems typologies (terrestrial, freshwater and marine), aiming at the elaboration, harmonization and comparison of ecological parameters across eco-domains, with a long-term, perspective. We are confident that this crucial trait of EnvEurope, as well as of LTER-Europe, will represent an added value for this Conference. The Project EnvEurope partners are all joining the Conference in a very collaborative spirit, being certain of the fruitful and interesting outcomes and view exchanges that will take place during the meeting.

Alessandra Pugnetti
Institute of Marine Science, National Research Council of Italy
Castello 1364/A – I 30122 Venezia, Italy, EnvEurope Project Coordinator

ICP Integrated Monitoring (IM) contributions to the International Union for Forest Research Organizations (IUFRO)

The International Co-operative Programme on Integrated Monitoring of air pollution effects on ecosystems (ICP IM) welcomes the opportunity to collaborate with the IUFRO Conference on Biological Reactions of Forests to Climate Change and Air Pollution in highlighting the importance of forest ecosystems in the environment. The participation at this event of the EU COST Action FP0903 on "Climate Change and Forest Mitigation and Adaptation in a Polluted Environment" and the Long-Term Ecological Research evaluation project EnvEurope will further enhance this meeting. The combination of diverse programmes represented at this meeting provides a holistic view of the forest environment and will greatly facilitate the important knowledge exchange needed to enhance sustainable management of forests today and in the future.

The ICP IM programme on Air Pollution Effects on Ecosystems within the Convention of Long-Range Transboundary Air Pollution and UN ECE Working Group on Effects is a multi-disciplinary programme which performs simultaneous measurement of physical, chemical and biological properties of ecosystems over time and across compartments at the same location so as to provide a holistic assessment of pollution effects. In practice, ICP-IM monitoring is divided into a number of compartmental sub-programmes which are linked by the use of the same parameters at the same or close by stations. The programme is focused on natural and semi-natural forest ecosystems so as to better understand the long-range and wide spread pressures on the environment. Direct influence from anthropogenic land use and land management activities, especially forestry, is avoided so that the observed ecosystem behavior can be better related to external global-scale stressors such as air pollution and climate change. Data collected under the ICP-IM programmes also furnishes vital reference information on background conditions to other investigations of anthropogenic effects on the environment.

The ICP IM focus is on determining and forecasting the state of the forest ecosystem with soils, surface water and vegetation and aims at delivering a sustainable long-term balance between the effects of air pollution, climate change and biodiversity. Furthermore, here should be additional strengthening of capacities to monitor and model interactions between multiple-pollutants and multiple-issues. It is important to understand physical, chemical and biological processes leading to effects on soils and water in the catchments and on vegetation in response to air quality and climate change. Atmospheric deposition is mainly directed on nitrogen, sulphur and metals.

In this IUFRO conference various directions of interest meet and exchange of information will provide new insights in the forest ecosystem functions. Presentations will lead to enhanced understanding of important parts of our environment and provide the basis for stimulating debate about new research avenues.

Lars Lundin, 2012-03-19

Air Pollution Workshop

Professor Algirdas Augustaitis
Faculty of Forestry
Aleksandras Stulginskis University
Kaunas, Lithuania

May 3, 2012

Dear Professor Augustaitis,

Congratulations to you and the faculty and administration of the Aleksandras Stulginskis University on the occasion of holding the international conference ***"Biological Reactions of Forests to Climate Change and Air Pollution"*** at your University on May 21-25, 2012. This conference co-organized by the IUFRO Research Group 7.01, COST Action FP 0903, ENVeurope and the North American Air Pollution Workshop is an excellent example of the international collaboration in air pollution effects research.

This event will enhance our understanding of the effects of air pollution and climate on forests with an ultimate goal of improving their health, sustainability and productivity in the Baltic States and worldwide. Thank you for your part in making this happen.

Regards,

Fitzgerald Booker

Fitzgerald L. Booker,
on behalf of the Air Pollution Workshop
North Carolina State University
Raleigh, North Carolina USA

USDA **United States Department of Agriculture** **Forest Service** **International Programs** **1099 14th St. NW, Suite 5500W 202-273-4695**

File Code: 1550
Date: April 23, 2012

Professor Algirdas Augustaitis
Faculty of Forestry
Aleksandras Stulginskis University
Kaunas, Lithuania

April 23, 2012

Dear Professor Augustaitis,

My sincere congratulations to you personally and to the Aleksandras Stulginskis University on the occasion of holding at your university the international conference ***"Biological Reactions of Forests to Climate Change and Air Pollution"*** . This conference, organized jointly by the IUFRO Research Group 7.01.00, North American Air Pollution Workshop, COST Action FP 0903, and ENVeurope, is of very high importance for the forestry scientists, managers and decision makers dealing with air pollution and climate change effects on forests worldwide. For the first time, the conference is being held in Lithuania, a country that is a very active member of the Baltic States and the European Union.

I am happy that USDA Forest Service International Programs is able to co-sponsor your conference and to help young scientists and students in participating in this important meeting. We strongly believe that events like this one greatly help in improving the well-being of forests and people who depend on healthy and productive forests as well as their ecosystem services worldwide.

Sincerely,

Dr. Valdis E. Mezainis
Director of International Programs

Caring for the Land and Serving People

Printed on Recycled Paper

Dear Participants of Joint International Conference

I am very much pleased to welcome the participants of the International Conference 'Biological Reactions of Forests to Climate Change and Air Pollution' on our university campus. We as Aleksandras Stulginskis University (ASU) community are very much honoured to host such an important event, which, we hope, will enhance research and will have impact on social, environmental and economic development worldwide. The vision of our university is designated to address the greatest local and global challenges, and we seek to become not only a leading centre of the interdisciplinary science and technology but also a university attaining for academic quality.

Our forestry resources are rather significant, that is why the research of forest ecosystems under the climate change is our top priority. I do believe that a better understanding of the integrated effects of air pollution and climate change on forests could be reached during the discussions at the Conference. I hope that it will allow developing reliable scenarios of climate change and air pollution effects on forest conditions and sustainability while adapting at and mitigating climate changes.

Let me also take this opportunity to acknowledge and thank the scientists who I hope will not only contribute to the constructive and collaborative discussions which will lead to scientific and technological progress but also make this conference a meaningful and effective event.

Yours sincerely

Prof. Antanas Maziliauskas
ASU Rector

Global changes and forest sustainability are increasingly becoming of greater and greater concern. To date, it is important to see what further measures are needed to understand and estimate the effect of the changing environment on biota. There are large uncertainties concerning the response of forest ecosystems to reduced emission load. At what level of acid deposition can we expect recovery of the ecosystems, and especially of their biological components (diversity and abundance)? What is the effect of different forms of nitrogen deposition (NHx and NOy)? What tendencies in the air pollution of acidifying species and ozone can we expect and what new synergetic effect occurs under rapidly changing environmental conditions? These issues are becoming increasingly more relevant also due to our limited knowledge on the effect of surface ozone on the physiological processes in plants or forest sustainability in general.

The Integrated Monitoring Programme, which has been performed for more than 20 years in Europe, provides for extended data on these issues and may be one of the ways of advancing our knowledge on recovery and functioning of the forest ecosystems under changing environment. Despite this new programmes are designed to solve similar present day problems. The main objectives of COST action FP 0903 are to increase understanding of state and potential of forest mitigation and adaptation to climate change in a polluted environment and to reconcile process-oriented research, long-term monitoring and applied modeling at comprehensive forest research sites (Supersites), with the main aim of integrating soil, plant and atmospheric sciences, monitoring, and policy-oriented modelling with scientifically sound indicators of pollution and climate-related risks. ENVeurope project is ready to introduce a design for environmental high quality monitoring sites and the exemplary establishment of common parameter sets to be collected across the largest site-based network of Long-Term Ecosystem Research in Europe. It focuses on three types of ecosystems: terrestrial, freshwater and marine ones, and aims at defining measures relevant to different levels of investigation, with specific monitoring intensities and with methods adjusted to the respective assessment intensity, implementing a multi-level and multi-functional monitoring approach with the aim to test new harmonized methods. The Air Pollution Workshop provides an informal setting for presentations and discussions of current research topics and issues on various aspects of air pollution effects on agricultural crops, forests and ecosystems. It is evident that in recent years, issues related to climate change effects have become part of the scope of the Workshop. The regional effects of pollutants, especially ozone, nitrogen deposition and particulate matter, are the issues of central importance.

Finally, IUFRO WG 7.01.00 – Impacts of air pollution and climate change on forest ecosystems, promotes international cooperation for more than 25 years encouraging an interactive process between scientists, policy makers and representatives of local to regional governments and institutions, in order to share scientific knowledge and harmonize effective strategies aimed to reduce the risk for forests related to air pollution and climate change. Therefore, the "Potpourri" session of the joint IUFRO&APW&COST&ENVeurope&ICPIM meeting offers a unique possibility and basis to discuss the significance of long term ecological research solving the main problem – reaction, adaptation and sustainability of ecosystems to changing air pollution and climatic condition as well as mitigating the processes of global changes.

Organisers of this great event wish you successful work in the sessions, unforgettable impressions over the pre-, in- and post- conference scientific trips, high spirits and good will solving all arising scientific problems. We welcome you in Lithuania and our Aleksandras Stulginskis University and God bless you.

Algirdas and Ingrida Augustaitis

Scope and objectives

The variation of forest growth and vitality conditions in relation to natural and anthropogenic factors is increasingly growing of concern for researchers who are studying the impact of air pollution and climate change on forest ecosystems. Changes in air temperature followed by changes in humidity regime are becoming one of the key factors comprising the global change threat to forest condition. Its effect on the distribution and deposition of air pollutants can alter air quality. Vice versa, pollutants can modify responses of ecosystems to specific climate change impacts or the climate in general. A better understanding of the integrated and synergetic effects of air pollution and climate change on forests is expected to be reached during the Conference to maximize forest research, monitoring and management and efficiency of the environmental policies. We hope that it will allow developing reliable scenarios of climate change and air pollution effects on forest conditions and sustainability while adapting at and mitigating climate changes. Therefore the following objectives are drawn:

To date, when sulphur emissions have decreased due to complete implementation of the Gothenburg Protocol and other legislation, the continuing rise in the emissions of precursor substances (VOC, NO, NO_2) resulted in a rise in ozone (O_3) concentrations. Evidence of damages of this newly recognized global agent of climate change is more and more frequently recorded not only in North America and Southern Europe, but also in Central and Northern Europe. Therefore, the presentation of the data on O_3 effects supplemented with data on ecologically relevant experimentation on the actual O_3 uptake in trees and forests and models for the reliable O_3 risk assessment are expected over the Conference.

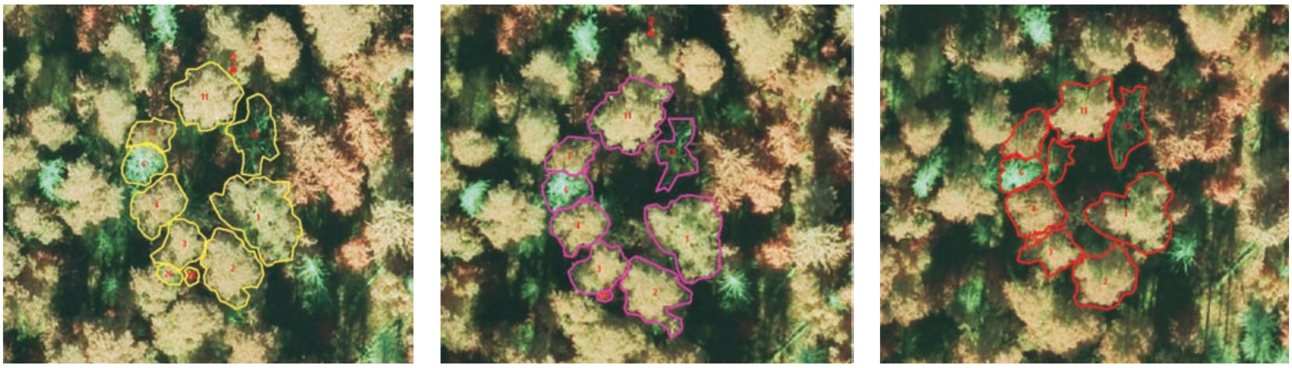
Element fluxes, soil-mediated parameters and water supply under changing meteorological conditions which may cause nutrient deficiencies and aggravate natural stress, such as physiological drought and occurrence of pests and diseases should become indispensable information for better understanding of the effects of disturbances on forests. With respect to the relevance of the potential effect of climate change on the distribution of air pollutants, we hope to find out if climate change will reduce or enhance the direct effect of air pollution and indirect – soil-mediated effect on the functioning and sustainability of the ecosystem.




The understanding of complex processes of adaptation and survival of populations under various stress conditions requires synergistic approaches which combine information about gene expression with a large variety of physiological and morphological traits. We believe that the experts of environmental genetics from the entire world who will attend the Conference will be ready to fill the gaps in the field of the impacts of climate change on genetic structures of species and their consequences for adaptation.


Despite all the past scientific efforts and international events the knowledge gaps in understanding the impacts of climate change on environmental pollution, on forest health and productivity, on the carbon cycles and sequestration in forest ecosystems, on the range and pace of shifts in biodiversity of local and alien species, on the disease, pest and fires in forest ecosystems, and on the weakening of resistance against invasive species remains. To solve these problems it is imperative to reorganise the long term ecological research network into suitable supper-sites for reflecting ecological, political and economic stratification of Europe. It will allow accounting for the effects of extreme years, past and present management practices, what should help to understand the effects of forestry treatments on the nutrient and water budgets of the ecosystems which may enable to make political decisions for improving management strategies and practices. We also need reliable methods to identify social and economic aspects of individual damages towards forests.

Uncertainties in this field could be reduced by means of remote sensing technologies, which include aerial photography, satellite images, and laser scanning for collecting data on environmental changes in the past, present and future. Based on the application of LiDAR and hyperspectral cameras most recent research is conducted in the fields of forest state assessment, forest inventory, soil and water quality. These advanced techniques offer new possibilities for sustainable forest management under changing climate, which might help to develop reliable scenarios of climate change and air pollution effects on forest adaptation and mitigation abilities and develop new linkages between researchers, data providers and product end-users.



Expected results

The organising committee of the international scientific Conference **"Biological Reactions of Forests to Climate Change and Air Pollution"** believes that the conference will greatly help in integrating science on the impacts of air pollution and climate change on forests. Experts from the various scientific disciplines from Europe, North America and other continents will gather at the Aleksandras Stulginskis University in the interdisciplinary forum to share current state of knowledge and discuss scientific gaps in the understanding of the integrated effect of climate change and air pollution on forest ecosystems. The scientists will also discuss how the predicted changes in climate and chemical environment may affect terrestrial and freshwater ecosystems, their biodiversity and sustainability. In addition, scenarios for adaptation of forests to those changes as well as mitigation of the climatic and chemical changes will be reviewed.

Notes

Programme

Friday, May 18

Arrival day for the participants who take part in pre conference tour.

18:00 –	Ice breaking party on the Campus of Aleksandras Stulginskis University

Saturday, May 19

7:00	Departure to Curonian Spit National Park

Sunday, May 20

19:00 –	Ice breaking party at the Park Inn Hotel

Monday, May 21

7:30 – 10:15	Registration
8:15 – 9:45	Opening session **Chair persons: Algirdas and Ingrida Augustaitis**

Welcome from the local Host
Welcome from the Rector's office of Aleksandras Stulginskis University
Welcome from the Lithuanian governmental institutions
Welcome from IUFRO, COST Action FP0903, APW, EnvEurope, ICP IM, LTER

9:45 – 10:15	Coffee break
10:15 – 12:00	Session 1 **"Air Pollution, Climate Change, and Forest Growth"** **Chair persons: Andrzej Bytnerowicz and Elena Paoletti**
12:00 – 13:00	Lunch
13:00 – 14:45	Session 2 **"Atmospheric Deposition, Soils and Nutrient Cycling"** **Chair persons: Mark Fenn and Jesada Luangjame**
15:15 – 17:00	Session 3 **"Forest Health, Methods and Tools for Forest Monitoring"** **Chair person: Marcus Schaub, co-chair Algirdas Augustaitis**
18:00 – 19:30	Old Town sightseeing.
19:30 – 21:30	Welcome at the city hall.
21:30 – …	Dinner in recommended restaurants in the Old Town (on your own)

Tuesday, May 22

8:00 – 9:45	Parallel business meeting ENVeurope
8:00 – 9:45	Session 4 **"Dedicated to Satu Huttunen"**. **Chair persons: Sirkku Manninen and Allan Legge.**
9:45 – 10:15	Coffee break
10:15 – 12:00	Parallel business meeting ENVeurope
10:15 – 12:00	Session 5 **"Multiple Stressor Effects on Ecosystems"** **Chair persons Nancy Grulke and Mikhail Kozlov** (Part 1)
12:05 – 13:00	Lunch
13:00 – 14:45	Session 6 **"Multiple Stressor Effects on Ecosystems"** **Chair persons: Nancy Grulke and Mikhail Kozlov** (Part 2)
14:45 – 15:15	Coffee break
15:15 – 17:00	Session 7 **"Environmental Quality and Pressures Assessment under Global Changes"** **Chair persons: Lars Lundin and Alessandra Pugnetti** Organized by ICP IM and ENVeurope.
18:00 – 20:00	Pazaislis Monastery sightseeing
21:00 – …	Dinner in recommended restaurants. (on your own)

Wednesday, May 23

8:00 – 12:00	For those who do not attend the following business meetings: Excursion to Lithuanian Forest Research Institute and ICP Forest Monitoring Level 2 Plot or pine forest surrounding nitrogen fertilizers plant JV"Achema". (upon personal request)
8:00 – 12:00	Parallel business meeting COST FP0903 – MC & WG meetings
8:00 – 12:00	Parallel business meeting ENVeurope
8:00 – 12:00	Parallel task force meeting ICP IM (Hotel Park Inn)
8:00 – 12:00	Parallel business meeting APW.
10:00 – 10:30	Coffee break
12:00 – 13:00	Lunch
13:00 – 17:00	Parallel business meeting COST FP0903 – MC & WG meetings

13:00 – 17:00 Parallel business meeting ENVeurope

13:00 – 17:00 Parallel business meeting ICP IM

14:45 – 15:15 Coffee break

13:00 – 14:45 Session 8 **“Genetic Aspects”**
Chair persons: Gerhard Müller-Starck and Om P. Rajora

14:45 – 15:15 Coffee break

15:15 – 17:00 Session 9 **“Hydroecology”**
Chair persons: Yusuf Serengil and Stanislaw Malek

18:00 – 18:45 IUFRO officers business meeting (Hotel Park Inn)

19:00 – 24:00 Gala dinner (Hotel Park Inn)

Thursday, May 24

8:00 – 9:45 Session 10 **“Mechanisms of Action and Indicator Development”**
Chair persons: Rainer Matyssek and Alessandra Kozovits.

9:45 – 10:15 Coffee break

10:15 – 12:00 Session 11 **“Modeling and Risk Assessment”**
Chair persons: Salim Belyazid and Wim de Vries

12:05 – 13:00 Lunch

13:00 – 14:45 Session 12 **“Potpourri”** (105 min)
Chair person: John King
Session is organized ad hoc during the conference (no pre-conference arrangements). Each presentation of this session is not longer than 5 minutes and 3-4 slides with plenty of discussion.

14:45 – 15:15 Coffee break

15:15 – 17:00 Poster Session
Chair persons: He Shang and Vitas Marozas

17:00 – 18:00 Closure of the Meeting

Friday, May 24

7:00 – 24:00 Scientific trip to Aukštaitija IMS on the way visiting of the most famous historical and sightseeing objects (Molėtai observatory)

Oral presentations

Session 1 **"Air Pollution, Climate Change, and Forest Growth"**

Chair persons: Andrzej Bytnerowicz and Elena Paoletti

No.	Time	Authors	Country	Title
1.	10:15 – 10.30	A. Augustaitis, I. Augustaitiene, R. Juknys, A. Vitas	Lithuania	**Do recent changes in environmental condition favour the growth of Scots pine and Norway spruce trees in Lithuania?**
2.	10:30 – 10:45	A. Sellin	Estonia	**Impact of elevated atmospheric humidity on performance of silver birch (*Betula pendula*)**
3.	10:45 – 11:00	H. Shang, Z. Chen, B. Lin	China	**Responses of the radial growth of trees to climate change at the timberline in southeast Tibetan Plateau: Difference between the shade-tolerant and intolerant tree species**
4.	11:00 – 11:15	Z. Libiete-Zalite, A. Jansons	Latvia	**Climate impacts on lodgepole pine (*Pinus contorta* var. *latifolia*) height growth in Latvia**
5.	11:15 – 11:30	B.G.Ageev, Yu.N. Ponomarev, V.A. Sapozhnikova, D.A. Savchuk	Russia	**Annual tree ring CO_2 and environmental changes**
6.	11:30 – 11:45	E. Gottardini, F. Cristofolini, M. Confalonieri, A. Cristofori, G. Gerosa, A. Finco, M. Ferretti	Italy	**Monitoring, surveying, modelling and mapping to detect ozone effects on forests in Trentino (Italy) – the ozone EFFORT project**
7.	11:45 – 12:00	C.Branquinho, P.Pinho, P.Matos, A.Nunes, S.Augusto, C.Máguas	Portugal	**Ecological indicators of global change: what do they tell us about the air pollution and climate change in the south of Portugal?**
	In reserve	Ch.Maximilian Ani, M. Lampe, P. Zong	China	**Environmental Air pollution monitoring and measurement using Wireless Sensor Networks**

Session 2 **"Atmospheric Deposition, Soils and Nutrient Cycling"**

Chair persons: Mark Fenn and Jesada Luangjame

No.	Time	Authors	Country	Title
1.	13:00 – 13.15	K. Armolaitis, A. Augustaitis, E. Bartkevičius, V. Stakėnas, V. Stravinskienė, J. Šepetienė, I. Kabašinskienė, E. Plaušinytė, V. Marozas, J. Aleinikovienė	Lithuania	**Nitrogen air pollution: decline and recovery of Scots pine (*Pinus sylvestris* L.) forest ecosystems**

2.	13:15 – 13:30	P. Merilä, K. Derome, A.J. Lindroos, S. Nevalainen, T.M. Nieminen	Finland	**An increasing trend in nitrate concentration in soil percolation water in a Norway spruce stand under low nitrogen deposition in Finland**
3.	13:30 – 13:45	M.Ferretti, A.Marchetto, F.Bussotti, M.Calderisi, R.Canullo, S.Carnicelli, G.Cecchini, G.Fabbio, G.Bertini, G.Matteucci, B. De Cinti, E.Pompei, L.Salvati	Italy	**Nitrogen deposition and Critical Load exceedance: effects on health, growth and diversity of forest vegetation in Italy**
4.	13:45 – 14:00	H.García, J.L.Garrido, M.G.Vivanco, L.Lassaletta, I.Rabago, A.Avila, G.Sánchez, A.González, I.González-Fernández, R.Alonso	Spain	**Trends in nitrogen deposition in Spain: comparison of measured and modeled data**
5.	14:00 – 14:15	V.J. Bruckman, Sh. Yan	Austria	**Nutritional status of *Quercus* dominated forest ecosystems for Biomass production**
6.	14:15 – 14:30	N. Torlopova, E. Robakidze, K. Bobkova	Russia	**Water Migration of Organic Carbon and Nitrogen in Old-aged Spruce Forests of the Middle Taiga Subzone**
7.	14:30 – 14:45	M.E. Fenn, A.Bytnerowicz, D. Schirokauer, L.H. Geiser, K. Dillman	USA	**Effects of Cruise Ship Emissions on Air Quality and Vegetation in Southeast Alaska**

Session 3 **"Forest Health, Methods and Tools for Forest Monitoring"**

Chair persons: Marcus Schaub and Algirdas Augustaitis

No.	Time	Authors	Country	Title
1.	15:15 – 15.30	S. Fares, G. Matteucci, G.S. Mugnozza, E. Paoletti, F. Loreto.	Italy	**Measurements of stomatal ozone fluxes and effects in a mixed Mediterranean oak forest**
2.	15:30 – 15:45	G.Gerosa, A.Finco, A. Negri	Italy	**Ozone fluxes to a larch forest ecosystem at the timberline in the Italian Alps**
3.	15:45 – 16:00	O.Badea, S.Neagu	Romania	**Forest Monitoring – assessment, analysis and warning system on forest ecosystem status**
4.	16:00 – 16:15	M. Pietras, R.Jaszczak, M.Miotke, T.Leski, M.Rudawska	Poland	**The ectomycorrhizal fungi in declining pedunculate oak (*Quercus robur* L.) stands**
5.	16:15 – 16:30	M.Pilkauskas, A.Augustaitis, E.Beniusis, A.Kliucius, V.Marozas, A.Vitas, A.Bytnerowicz, T.Staszewski, Ā.Jansons, A.Dreimanis	Lithuania	**Growth peculiarities of European beech trees on the west – east gradient in Lithuania**
6.	16:30 – 16:45	O.Miezīte, A.Lazdiņš, M.Okmanis, R.Āls, K.Polmanis	Latvia	**Role of scale predator *Anthribus nebulosus* in control of population of *Physokarmes piceae* Schrnk in Norway spruce *Picea abies* (L.) Karst. Ecosystem**

7.	16:45 – 17:00	Z.Feng, W.Zhang, X.Wang, J.Uddling	Sweden, China	**Leaf mass per area (LMA) contributes to the sensitivity of tree species to elevated ozone**

Session 4 **"Dedicated to Satu Huttunen"**

Chair persons: Sirkku Manninen and Allan Legge.

No.	Time	Authors	Country	Title
1.	8:00 – 8.15	A.Bytnerowicz, M.E. Fenn	USA	**Nitrogen and sulfur air pollution and atmospheric deposition in the Athabasca Oil Sands Region, Alberta, Canada**
2.	8:15 – 8.30	E.Paoletti, Y.Hoshika, W.J. Manning	Italy, Japan, USA	**Ambient ozone exposure affects carbon allocation and gas exchange in poplars treated with the antiozonant ethylenediurea for three years**
3.	8:30 – 8.45	J. Burkhardt	Germany	**Direct interactions of hygroscopic particles with leaf/needle surfaces and plant water relations**
4.	8:45 – 9.00	A.Hyyryläinen, J.Martínez-Abaigar, F.Martz, P.Rautio, M.Turunen, S.Huttunen	Finland Spain	**The impact of temperature and solar UV radiation on chlorophyll and phenolics of Sphagnum sp.**
5.	9:0 – 9.15	M.Mäenpää, S.Kontunen-Soppela, M.Rousi, E.Oksanen	Finland	**Assimilation, acclimation and allocation responses of birch and aspen to increasing temperature and oxidative stress**
6.	9:15 – 9.30	C.Chutteang, R.Marushima, M.Takeda, G.Zhenrui, P.Na-ngern, Buhe, F.Takemasa, Sh.Hatakeyama, M.Aoki	Japan	**Single and combined effects of peroxides and ozone for consecutive three years on visible leaf injury, growth, and mineral content of beech seedling**
7.	9:30 – 9.45	A.Legge, S.Krupa, M.Landis, P.Pancras, E.Edgerton, J.Graney, J.Blum, W.Studabaker, J.Raymer, R.K.M. Jayanty, K.Percy	USA, Canada	**Apportionment of Multiple SO_x and NO_x Source Emissions and their Deposition for Ecological Effects Assessment**

Session 5 **"Multiple Stressor Effects on Ecosystems"**

Chair persons Nancy Grulke and Mikhail Kozlov

(1st part)

No.	Time	Authors	Country	Title
1.	10:15 – 10.30	Z.Kongoi, L.Bonten, Wim de Vries	The Netherlands	**Impacts of changes in climate, nitrogen deposition, ozone and CO_2 exposure on forest carbon sequestration: a meta-analysis**

2.	10:30 – 10:45	P.Cudlín, T.Müllerová, P.Štěpánek, A.Farda, M.Edwards-Jonášová, T.Žid, P.Čermák, S.Křístek, P.Tuček	Czech R.	**Multiple stressor effect analysis for future risk assessment of spruce forests in the Slezske Beskydy Mts. (Czech Republic)**
3.	10:45 – 11:00	V.Zverev, M.V. Kozlov	Finland	**Climate modifies effects of industrial pollution on growth of mountain birch**
4.	11:00 – 11:15	S.Małek, J.Barszcz, K.Januszek, M.Kroczek	Poland	**Assessment of the reforestation success of fertilized cultures of *Fagus sylvatica* L. and *Abies alba* Mill. grown uder the canopy of spruce stands threatened with disintegration in the Beskid Śląski and Żywiecki Mts**
5.	11:15 – 11:30	O.Zaļkalns, I.Liepa	Latvia	**Response reactions of Norway spruce to changing air pollution and weather conditions in Kurzeme**
6.	11:30 – 11:45	A.Rodrigues, G.Pita, M.Casquilho	Portugal	**Evaluation of the potential of sequestration of atmospheric carbon in a Portuguese eucalypt stand under conditions of water stress**
7.	11:45 – 12:00	A.Giuggiola, A.Rigling, M.Dobbertin	Switzerland	**Multiple stress induced decline of Scots pine in dry inner-alpine valleys in Switzerland**

Session 6 **“Multiple Stressor Effects on Ecosystems”**

Chair persons: Nancy Grulke and Mikhail Kozlov

(2nd part)

No.	Time	Authors	Country	Title
1.	13:00 – 13.15	P. Pinho, C. Branquinho	Portugal	**Using lichen functional groups as indicators of the effects of multiple stressors on ecosystems**
2.	13:15 – 13:30	S. Braun, R. Mainiero, W. Flückiger	Switzerland	**Nitrogen and water use paramets of young *Fagus sylvatica***
3.	13:30 – 13:45	M.Goisser, U.Zang, R.Matyssek, K.H.Häberle, W.Borken, E.Matzner	Germany	**Response of beech saplings to extreme and repeated summer droughts of relevance for stand establishment in the future**
4.	13:45 – 14:00	A.Kühn, M.Baumgarten, H.P.Dietrich, R.Matyssek	Germany	**Intra-annual growth of adult beech (*Fagus sylvatica* L.) – influenced by short term water limitation and ozone uptake?**
5.	14:00 – 14:15	M.Urbaniak, B.H.Chojnicki, A.Danielewska, M.Baran, J.Olejnik	Poland, Czech R.	**Measurements of mass and energy exchange between pine afforestation and the atmosphere – past, present and future research at Tuczno site (Poland)**

6.	14:15 – 14:30	I.Mészáros, P.Kanalas, B.Nyitrai, J.Kis, A.Fenyvesi, V.Oláh, Z.Demeter, E.Szőllősi	Hungary	**Diurnal and seasonal variation in stem radius and water status of mature sessile oak *Quercus petraea* (Matt.) Liebl. and turkey oak *Quercus cerris* L. trees in relation to weather conditions**
7.	14:30 – 14:45	S.Luguza, I.Liepa, K.Cirse	Latvia	**Role of tree growth active periods in dendroecological research**

Session 7 **"Environmental Quality and Pressures Assessment under Global Changes"**

Chair persons: Lars Lundin and Alessandra Pugnetti
Organized by ICP IM and ENVeurope.

No.	Time	Authors	Country	Title
1.	15:15 – 15.30	J. Vuorenmaa, M. Forsius, L. Lundin, S. Kleemola, A. Augustaitis, B. Beudert, H.A. de Wit, C.D. Evans, J.Frey, I. Indriksone, D. S. Jeffries, P. Krám, M. Váňa	Finland	**Sulphur and nitrogen input-output budgets at ICP Integrated Monitoring sites**
2.	15:30 – 15:45	R.Jakuš	Slovakia	**The development of "supersite" plot and forest dynamic observations system in Polana mountains**
3.	15:45 – 16:00	T.Dirnböck, U.Grandin	Austria, Sweden	**Long-term vegetation responses at ICP IM sites in relation to deposition impacts**
4.	16:00 – 16:15	M.Holmberg	Finland	**Empirical impact indicators agree with exceedances of critical loads**
5.	16:15 – 16:30	S.Löfgren, M.Aastrup, L.Bringmark, H.Hultberg, L.Lewin-Pihlblad, LLundin, G.P.Karlsson, B.Thunholm	Sweden	**Recovery of soil water, groundwater and streamwater from acidification at the Swedish Integrated Monitoring catchments**
6.	16:30 – 16:45	G.Matteucci, M.Frenzel, M.Bascietto	Italy, Germany	**Testing common monitoring and research parameters: the EnvEurope field exercise**
7.	16:45 – 17:00	H.A.deWit, J.Blaszczak	Norway	**Mercury in stream and wetland porewater in two Norwegian catchments**
	In reserve	M.Frenzel, S.Stoll, C.Baessler, M.Bastianini, G.Matteucci, A.Campanaro, B.Burkhard	Germany, Italy	**Indicator assignment and selection for Long-Term Ecosystem Research (LTER) and Monitoring sites**

Session 8 **"Genetic Aspects"**

Chair persons: Gerhard Müller-Starck and Om P. Rajora

No.	Time	Authors	Country	Title
1.	13:00 – 13.15	O.P. Rajora, J.Kim, J.E. Major	Canada	**Genic responses of black spruce to climate change**

2.	13:15 – 13:30	T.O.Best	USA	**Comparative genomics of ozone stress response in hardwood tree species**
3.	13:30 – 13:45	J.Dumont, S.Keski-Saari, M.Keinanen, S.Kontunen-Soppela, D.Cohen, N.Ningre, Ata Allah Dghim, M.N.Vaultier, P.Baldet, Y.Gibon, D.LeThiec P.Dizengremel, Y.Jolivet, E.Oksanen,	France, Finland	**Ozone-induced detoxification processes in three *Populus* genotypes: Metabolomic and molecular approaches**
4.	13:45 – 14:00	R.Longauer, D.Gömöry, M.Pacalaj	Slovakia	**Tree Genetics and Reconstruction of Secondary Coniferous Forests: A case Study from the Western Beskids Mts., Slovakia**
5.	14:00 – 14:15	A.Jansons, L.Purina, B.Dzerina, O.Krisans, U.Neimane	Latvia	**Genetic differences in lammas growth of Scots pine in response to prolonged vegetation period**
6.	14:15 – 14:30	D.Krabel, K.Morgenstern	Germany	**Boon and bane of endophytes in a changing environment**
7.	14:30 – 14:45			

Session 9 **"Hydroecology"**

Chair person Yusuf Serengil, co-chair Stanislaw Malek

No.	Time	Authors	Country	Title
1.	15:15 – 15.30	K.Krakowian, S.Malek	Poland	**The impact of deforestation caused by ecological disasters on the spring water chemistry in the Beskid Śląski Mts.**
2.	15:30 – 15:45	N.Yamashita, H.Sase, R.Kobayashi, Sh.Uchiyama, S.Urban, T.Ying Ying, N.Chappell	Japan, UK	**Stream water chemistry and internal nutrient fluxes in a Malaysian tropical rainforest**
3.	15:45 – 16:00	H.Sase, N.Yamashita, Sh.Uchiyama, R.Kobayashi, J.Shindo, K.Matsuda, M.Nakata	Japan	**Atmospheric deposition and stream water chemistry in a Japanese cedar forest – 10-year surveys along Sea of Japan**
4.	16:00 – 16:15	M.Żelazny, Ł.Jelonkiewicz, A.Olech	Poland	**Displacements of Carbonate Equilibria in Polish Tatra Mountain Waters in the Last Fifty Years**
5.	16:15 – 16:30	Z.Galić, S.Orlović	Serbia	**Monitoring of soil moisture dynamics in fluvisol under changig climate conditions**
6.	16:30 – 16:45	M.Jasik, S.Małek, M.Pająk	Poland	**Changes in chemical composition of spring waters in the Świętokrzyski National Park under the influence of permanent high acid deposition**
7.	16:45 – 17:00	M.Čater	Slovenia	**Is there a perspective for oaks in Slovenian lowlands?**

Session 10 **"Mechanisms of Action and Indicator Development"**

Chair persons: Rainer Matyssek and Alessandra Kozovits.

No.	Time	Authors	Country	Title
1.	8:00 – 8.15	R.Matyssek, G.Wieser, A.R. Kozovits	Germany, Austria, Brazil	**Mechanisms of Action in and Indicator Development for Forests under Climate Change and Air Pollution – from Gaps in Evidence to Integrated Knowledge**
2.	8:15 – 8.30	H.S.Neufeld, J.Johnson, Ch.Dolan, R.Kohut	USA	**Differences in ozone sensitivity within and among two varieties of cutleaf coneflower (*Rudbeckia laciniata* var. *digitata* and *R. laciniata* var. *ampla*)**
3.	8:30 – 8.45	S. Małek, K. Januszek, J. Barszcz, M. Kroczek	Poland	**Ecochemical condition of soils after fertilization of dying old spruce (*Picea abies* (L.) H. Karst.) stands in the Beskid Śląski and Żywiecki Mts.**
4.	8:45 – 9.00	L.Sisenis, J.Rieksts-Riekstins, R.Rieksts-Riekstins, J.Jansons, A.Jansons	Latvia	**Possible use of introduced species *Pinus contorta* for biomass production in Latvia**
5.	9:00 – 9.15	N.Grulke, E.Paoletti, D.Grantz, R.Matyssek	USA, Italy, Germany	**Changes in threshold for Ps and gs decoupling with increasing O_3 concentrations in cultivated and uncultivated species**
6.	9:15 – 9.30	T.N. Mikkelsen, D.Bruhn, I.M. Møller, P.Ambus	Denmark	**Terrestrial plant methane production and emission**
7.	9:30 – 9.45	M.Medori, I.Nogués, C.Calfapietra	Italy	**Relationship between Volatile Organic Compounds emission and antioxidant compounds in *Cistus monspeliensis* under drought and warming stress**

Session 11 **“Modeling and Risk Assessment”**

Chair persons: Salim Belyazid and Wim de Vries

No.	Time	Authors	Country	Title
1.	10:15 – 10.30	M.Baumgarten, W.Weis, A.Kühn, R.Matyssek	Germany	**Evaluating forest stand transpiration from two perspectives – xylem sap flow measurement *versus* hydrological modeling**
2.	10:30 – 10:45	A. Morani, D. Nowak, V. Muzzini, S. Hirabayashi, S. Fares, C. Calfapietra	Italy	**Comparing modeled ozone absorption with field measurements in a periurban Mediterranean forest**
3.	10:45 – 11:00	D.A. Grantz, H.B.Vu, R.L. Heath, K.Burkey	USA	**Diurnal trends in ozone sensitivity and effective flux in *Gossypium*: Key to modeling impacts?**
4.	11:00 – 11:15	W.de Vries, M.Posch, D.Simpson, A.Nyiri, G.J.Reinds, L.Bonten	The Netherlands, Norway, Sweden	**Impacts of changes in climate, nitrogen deposition, ozone and CO_2 exposure on forest carbon sequestration: a model assessment**
5.	11:15 – 11:30	A.R.Kozovits, J.M.Lanna, T.G.de Senna Carneiro	Brazil	**Effects of CO_2 enrichment and intensification of dry seasons on Amazon rain forest biomass and structure simulated by Troll model**
6.	11:30 – 11:45	A.de Marco, M.Vitale, U.Kilic, E.Paoletti	Italy	**Ozone data from passive samplers and AOT40 estimation in Italy**
7.	11:45 – 12:00	R.Juknys, J.Vencloviene, A.Vitas, A.Augustaitis, A.Kliucius, E.Bartkevicius	Lithuania	**Dynamic response of tree growth to changing environmental pollution**

Poster session

Chair persons: He Shang and Vitas Marozas

Session 1 **"Air Pollution, Climate Change, and Forest Growth"**			
1.	M. Aoki, R. Marushima, C. Chutteang, P. Na-Ngern, M. Takeda, F. Takemasa, G. Zhenrui, B. Chen Xuan	Japan, Thailand	Peroxides concentrations at two places in central Japan under global warming
2.	L. Baležentienė, A. Užupis	Lithuania	GHG emissions seasonal response to different treatment of grassland ecosystems in the central Lithuania
3.	I. Berki, N. Móricz, E. Rasztovits	Hungary	The relationship among climate change, N-supply and sessile oak decline
4.	E. Çaliskan	Turkey	Forest roads planning and construction in Turkish forestry
5.	G. Georgieva, S. Bratanova, N. Chipev	Bulgaria	Long term dynamics of biotic and abiotic damages of forest ecosystems in Strandza Mountain (Southeast Bulgaria) in relation to climate change
6.	N.Köse, Ü.Akkemik, H.T.Güner, H.N.Dalfes, M.S.Özeren, H.D.Grissino-Mayer, T.Kındap	Turkey, USA	Tree-ring based May–June precipitation reconstruction for southwestern Turkey and its links to volcanic eruptions
7.	A. Koukhta	Russia	The temperature and precipitation effects on the annual linear Scotch pine increment on the banks of Kandalaksha bay
8.	M. Kukk, A. Sõber	Estonia	The effects of elevated air humidity on the development of silver birch (*Betula pendula* Roth) foliage in an experimental forest ecosystem
9.	B. Nyitrai, J. Kis, P. Kanalas, V.Oláh, E. Szőllősi, I. Mészáros	Hungary	Relationship between tree ring changes of two co-existing oak species and climate from North Hungarian Central Range, Hungary
10.	V.Stakėnas, P.Žemaitis, R.Ozolinčius	Lithuania	Meteorological factors and Norway spruce (*Picea abies* (L.) H. Karst.) condition in the habitats with different site humidity
11.	M. Zadina, A Jansons	Latvia	The influence of climate factors on Scots pine (*Pinus sylvestris* L.) seasonal height growth dynamics

Session 2 **"Atmospheric Deposition, Soils and Nutrient Cycling"**			
1.	K.Armolaitis, J.Aleinikovienė, J.Lubytė, V.Žėkaitė, P.Garbaravičius	Lithuania	Comparative study on the stability of soil organic carbon in forest and agroecosystems
2.	J.Baranauskaitė, V. Marozas, N.Sabienė, K.Petelis	Lithuania	The influence of fallow deer kept in enclosure on soil chemical properties

3.	A.Beniusis, A.Augustaitis, I.Augustaitiene, D.Danusievicius, A.Kliucius, V.Marozas	Lithuania	Growth of Scots pine, Norway spruce and Larch Siberian trees under the effect of changing nitrogen emissions and climatic condition
5.	R.Caggiano, R.Fikova, N.Ignatova, L.Telesca, S.Trippetta	Italy, Bulgaria	Rainfall modification in mountainous ecosystems dominated by *Fagus silvatica* and *Picea abies* (Western Balkans, Bulgaria): an assessment by multivariate analyses
4.	I.Hůnová, J.Maznová	Czech R.	Trends in Atmospheric Deposition in Czech Forests
6.	K.Januszek, E.Błońska, T.Wanic, S.Małek, J. Barszcz	Poland	Effect of mineral fertilization on soil enzymatic activity of spruce younger age classes in the Beskid Śląski and Żywiecki Mts.
7.	W. Łukasik, P. Kubiesa, T. Staszewski	Poland	Erosion Processes Caused by Logging in Mountain Areas. Wilczy Potok Valley in the Silesia Beskid Case Study
8.	M.Pająk, J. Socha, S. Małek, M. Jasik, S. Mucha	Poland	The influence of selected properties of the forest environment on the level of heavy metal accumulation in the soil surface layers in the immediate vicinity of the Bolesław Mine and metallurgical Plant in Bukowno (southern Poland)
9.	H.Sase, K.Matsuda, T.Visaratana, H.Garivait, N.Yamashita, B.Kietvuttinon, B.Hongthong, J.Luangjame, P.Khummongkol, J.Shindo, T.Endo, K. Sato, M.Miyazawa, M.Nakata	Japan, Thailand	Deposition process of ion constituents and black carbon in East Asian forests
11.	J. Sasnauskienė, V.Marozas, N.Sabienė	Lithuania	Impact of shelterwood cuttings on soil nitrogen in pine forests
12.	T.Staszewski, P.Kubiesa, W.Łukasik	Poland	Differences in PAHs deposition to leaves of *Quercus robur*, *Betula pendula*, and *Pinus sylvestris*
13.	L.Augustaitytė, A.Augustaitis, I.Baužienė, D.Jasinevičienė	Lithuania	Effect of gradually increasing ammonia atmospheric deposition on geochemical processes in soil at Aukštaitija IMS

Session 3 **"Forest Health, Methods and Tools for Forest Monitoring"**			
1.	A.Bārdulis, A.Bārdule, A.Lazdiņš	Latvia	Level II forest monitoring in Latvia
2.	E.Chudzinska, E.Pawlaczyk, J.Diatta	Poland	Reaction of the Scots pine (*Pinus sylvestris* L.) population to industrial pollution manifested in level of morphological and anatomical needle traits differentiation and coefficient of fluctuating asymmetry (FA)
3.	S.Cieslik, E.Paoletti, R.Matyssek, N.Grulke	Italy, Germany, USA	Stomatal Ozone Fluxes to Trees: Methodology for Air Quality Regulations to Protect Vegetation
4.	M.Eigirdas, G.Mozgeris, A. Augustaitis	Lithuania	Predicting tree crown defoliation using conventional for Lithuanian forest inventory color-infrared orthophoto maps

5.	M.P.Esposito, M.Domingos	Brazil	Ability of *Tibouchina pulchra* (Cham.) Cogn., a native species from the Atlantic Forest, to tolerate the oxidative stress around an oil refinery in Cubatão, Brazil
6.	T.Hlásny, Z.Sitková, I.Barka, M.Konôpka, T.Bucha	Slovakia	Forest vegetation response to heat and drought stress: The use of MODIS satellite imagery
7.	M.Edwards-Jonášová	Czech R.	Spontaneous recovery of mountain spruce forests after natural disturbances
8.	D.Jonikavičius, G.Mozgeris	Lithuania	Rapid assessment of wind storm caused forest damages using satellite images and stand-wise forest inventory data
9.	T.Koike, M.Watanabe, X.Wang, Sh.Tatsuta, A.Sakuma, T.Yamaguchi, I.Noguchi, H.Saito, Y.Hoshika	Japan	Declining symptom of mountain birch (*Betula ermanii*) in northern Japan
11.	M.Mandre, K-L.Tuju, T. Kuznetsova, A. Lukjanova, J.Klõšeiko, H.Pärn, K.Kikamägi, K.Ots	Estonia	Impact of alkaline dust pollution on the formation of the crowns of Scots pine and Norway spruce in the industrial region of Estonia.
12.	G.Masaitis, G.Mozgeris, A.Augustaitis	Lithuania	Spectral reflectance properties of healthy and damaged coniferous trees
13.	O.Miezīte, M.Okmanis, J.Ruba, K.Polmanis, L.Freimane	Latvia	Assessment of sanitary condition in bud scale *Physokarmes piceae* Schrnk. damaged Norway spruce *Picea abies* (L.) Karst. Stands
14.	B.B.Moura, E.S.Alves, S.R.de Souza, P.Vollenweider	Brazil, Switzerland	Foliar symptoms specific for ozone stress in rain forest trees of southern Brazil
15.	G.Mozgeris, A.Augustaitis	Lithuania	Estimating crown defoliation of Scots pine (*Pinus sylvestris L.*) trees using small format digital aerial images
16.	E.Pawlaczyk, M.A. Bobowicz	Poland	Impact of human activity on variability of the unique population of silver fir (*Abies alba* Mill.) from Tisovik Reserve (Belarus) expressed in microsatellite chloroplast DNA polymorphism
17.	Andrea.N.V. Pedroso, M.P. Esposito, M.Domingos	Brazil	Microscopic symptoms and antioxidant responses as integrated measurements of tolerance to air pollutants in a native species to the Atlantic Forest, Brazil
18.	A.Pilipovic, S.Orlovic, Z.Galic, S.Stojnic, B.Klasnja	Serbia	Soil respiration measurement in five different forest types in Serbia
19.	L.Pocienė, A.Augustaitis, I.Augustaitienė, A.Kliučius, G.Pivoras	Lithuania	Reaction of Scots pine crown condition to changes in air pollutants, acid deposition and meteorological parameters: cae studies in Lithuanian National parks
20.	N.Sidabras, G.Mozgeris, A.Augustaitis	Lithuania	Relationships between leaf area index and remotely sensed data
21.	M.C. Vitarana, W.D. Stock, A. Hinwood	Australia	Spatial distribution of lichen communities along a potential pollution gradient in a coal mining region of South West Western Australia

Session 5–6 **“Multiple Stressor Effects on Ecosystems”**			
1.	A.Indriksons, O.Miezīte, A.Dreimanis, I.Ozoliņa, R.Āls, A.Babris	Latvia	The dendrometrical characteristics of snow-inclined young growths of birch
2.	D.Lazdiņa, A.Bārdule, S.Rancāne, A.Bārdulis, K.Makovskis, M.Zeps, M.Daugaviete	Latvia	First results of growth characteristics of hybrid aspen, birch and grey alder fertilized plantation on former farmland
3.	E.Szőllősi, V.Oláh, P.Kanalas, J.Kis, B.Nyitrai, I.Mészáros	Hungary	Effects of contrasting weather conditions on leaf biochemical and physiological traits of canopy tree species in a mixed oak forest
4.	S.Plyusnina, R.Malyshev	Russia	Water freezing in Siberian spruce needles and buds

Session 7 **“Environmental Quality and Pressures Assessment under Global Changes”**			
1.	I.Baužienė	Lithuania	Quantitative and qualitative assessment of changes in main geosystems components of rivulet catchments at Lithuanian IM stations
2.	A.Danielewska, N.Clarke, J.Olejnik, K.Hansen, W.de Vries, L.Lundin, J.P.Tuovinen, R.Fischer, M.Urbaniak, E.Paoletti	COST	A metadatabase comparison from various European Research Networks
3.	T.Kliment, A.Oggioni	Italy	Crosswalk between EnvEurope (EML) and INSPIRE (EN ISO) metadata profiles – a step towards SEIS
4.	T.Marañón, I.M. Pérez-Ramos, R.Díaz-Delgado, T.Dirnböck	Austria	Global Change and mast seeding of European tree species. The *EUROMASTING* project
5.	S.Orlovic, M.Drekić, S.Pekeč, S.Stojnic, B.Klašnja	Serbia	Intensive monitoring of forest ecosystems in Serbia
6.	M.Vana	Czech Republic	Black carbon in the atmosphere and consequences for the global climate; site-based measurements at IM Observatory Kosetice
7.	M.Vana	Czech Republic	Long-term monitoring of methane in the atmosphere at Kosetice Observatory

Session 8 **“Genetic Aspects”**			
1.	E.M. Chudzinska, K.Celinski, J.Diatta, W.Pawlaczyk	Poland	Genetic diversity of black pine (*Pinus nigra* Arn.) population tolerant to heavy-metal pollution-microsatellite DNA analysis
2.	D.Danusevicius, V.Marozas, A.Augustaitis	Lithuania	An approach to study the genetic tolerance to industrial pollution in Scots pine
3.	V.Marozas, D.Danusevičius, A.Augustaitis, E.Plaušenytė	Lithuania	Indirect evidence of genetic tolerance to industrial pollution in Scots pine
4.	T.Wojda, J.Kowalczyk	Poland	Growth responses of silver birch (*Betula pendula* Roth) to environmental change

Session 9 **"Hydroecology"**			
1.	J Neil Cape	UK	From dry cleaning to dirt – trichloroacetic acid in forests
2.	J.Luangjame, H.Sase, N.Yamashita, Th.Visaratana, H.Garivait, B.Kietvuttinon, B.Hongthong, J.Shindo, K.Matsuda	Japan, Thailand,	Atmospheric deposition and stream water chemistry in a dry evergreen forest in northeast Thailand
3.	Y.Serengil, K.Şengönül, F.Gökbulak, İ.Yurtseven, B.Uygur	Turkey	Runoff and nutrient budgets in small experimental catchments in Istanbul, Turkey
4.	G.Wieser, M.Leo, T.E.E.Grams, R.Matyssek	Austria, Germany	Evaluating the effect of drought on inner-alpine coniferous trees: an approach based on sap flow measurements
5.	İ.Yurtseven, K.Şengönül, Y.Serengil	Turkey	Modeling Suspended Sediment Amount Using Artificial Neural Network in Forested Watershed
6.	U.Zang, M.Goisser, W.Borken, K.H.Häberle, T.Grams, E.Matzner, R.Matyssek	Germany	Recovery of rewetted beech saplings after drought: A ^{13}C labelling experiment
7.	M.Żelazny, M.Drewnik,	Poland	The effect of the soil properties on the chemical composition of spring waters (Tatra Mts., Poland)

Session 10 **"Mechanisms of Action and Indicator Development"**			
1.	A.Abraitienė, R.Girgždienė	Lithuania	Impact of elevated ozone concentration on plant and viral pathogen interaction
2.	C.Chutteang, G.Zhenrui, R.Marushima, P.N.Buhe, F.Takemasa, S.Hatakeyama, M.Aoki	Japan	Sensitivity comparison of single and combined effects of peroxides and ozone on leaf injury and chlorophyll content among three cultivars of *Brassica rapa*
3.	Z.Feng, W.Zhang, X.Wang, J.Niu	Sweden China	Responses of native broadleaved woody species to elevated ozone in subtropical China
4.	Y.Hoshika, M.Watanabe, N.Inada, T.Koike	Japan	Ozone develops sluggishness of stomatal light response progressively in Siebold beech (*Fagus crenata*).
5.	P.Kanalas, A.Fenyvesi, J.Kis, B.Nyitrai, V.Oláh, E.Szőllősi, Z.Demeter, I.Mészáros	Hungary	Comparative measurements of sap flow and trunk radial shrinkage in mature trees of two co-occurring oak species
6.	N.Karlıoğlu, E.Paoletti	Turkey, Italy	Stomatal sluggishness responses to ozone at different light intensities
7.	M.Katanić, E.Paoletti, S.Orlović, M.Hrenko, M.Bajc, T.Grebenc, H.Kraigher	Serbia, Slovenia, Italy	Mycorrhizal status of poplars exposed to ambient ozone and treated with the antiozonant ethylenediurea
8.	K.Kets, J.N.T. Darbah, A.Sober, J.Riikonen, J.Sober, D.F. Karnosky	Estonia, Finland, USA	Diurnal changes in photosynthetic parameters of Populus tremuloides, modulated by elevated concentrations of CO_2 and/or O_3 and daily climatic variation.

9.	S.Kontunen-Soppela, S.Keski-Saari, M.Keinänen, M.Rousi, E.Oksanen	Finland	Phenotypic plasticity and limits of adaptation in birch under climate change
10.	E. Kupcinskiene	Lithuania	Morphophysiological characters of ***Pinus sylvestris*** near main local pollution sources of Lithuania: past, present and future
11.	E.Oksanen, J.Lihavainen, M.Keinänen, S.Keski-Saari, S.Kontunen-Soppela, A.Sober	Finland, Estonia	Metabolic responses of birch leaves to increasing air humidity
12.	V.Oláh, E.Szőllősi, P.Kanalas, B.Nyitrai, J.Kiss, Á.Lakatos, G.Tóth, I.Mészáros	Hungary	Phenological dynamics of mature *Quercus petraea* [Matt.] Liebl. trees based on multi-seasonal analysis of leaf-scale morphology and chlorophyll fluorescence measurements
13.	M.D.de-Quijano, J.Peñuelas, T.Menard, P.Vollenweider	Spain Switzerland	Bioindications of ozone stress in foliage of Mountain pine (*Pinus mugo* subsp. *uncinata*) from the Catalan Pyrenees
14.	N.Sidabras, A.Augustaitis, I.Augustaitiene, G.Masaitis, V.Marozas, G.Mozgeris	Lithuania	Leaf area index (LAI) as indicator of stand productivity, health and biodiversity
15.	M.Urbaniak, M.Baran, B.H.Chojnicki, A.Danielewska, R.Juszczak, J.Olejnik	Poland	Chamber measurements of CO_2 fluxes in a pine forest in Poland, Tuczno case study
16.	P.Vollenweider	Switzerland	Tissue- and cell-level bioindications of climate change and air pollution in foliage of trees
17.	P.Vollenweider, T.Menard, M.Arend, M.Günthard-Goerg	Switzerland	Structural bioindications of drought stress and tolerance in foliage of oaks under experimental climate forcing
18.	M.Watanabe, N.Inada, Y.Hoshika, X.Wang, Q.Mao, T.Koike	Japan	Photosynthetic traits of *Fagus crenata* and *Quercus crispula* sapling grown under free air ozone exposure

Session 11 **"Modeling and Risk Assessment"**

1.	M.Aoki, Sh.Baba, R.Marushima, C.Chutteang, P.Na-Ngern, F.Takemasa, G.Zhenrui, Buhe, Ch.Xuan	Japan	Single and combined effects of organic peroxides and ozone on visible foliar injury and chlorophyll content of two vegetable species
2.	T.Hlásny, Z.Barcza, I.Barka, M.Fabrika	Slovakia, Hungary	Forest growth and carbon balance under climate change: simulation experiments on forest monitoring plots in Central Europe
3.	A.de Marco, P.Sicard, E.Paoletti, M.Vitale, C.Renou, G. Taburet	Italy	Comparison between POD and AOT40 in French and Italian forests
4.	P.Parvanova, N.Tzvetkova, S.Bratanova-Doncheva, N.Chipev, E.Donev, R.Fikova	Bulgaria	Stomatal ozone fluxes in leaves of *Quercus robur* and *Quercus rubra* seedlings exposed to ambient ozone in Plana Mountain

Special poster session **"Biodiversity and Alien Species under Global Pressure"**			
1.	V.Ambrazevičius, A.Augustaitis, I.Augustaitiene, A.Beniusis, A.Kliucius, V.Marozas	Lithuania	Sensitivity of alien coniferous species outside their natural distribution range to recent climatic condition
2.	K.Armolaitis, J.Aleinikovienė, V.Marozas, A.Augustaitis, A.Kliučius	Lithuania	Potential of some alien tree plantations in Lithuanian forests
3.	V.Baliuckas, L.Straigyte, R.Petrokas	Lithuania	The spread and invasiveness of *Q.rubra* and *F.sylvatica* – an introduced forest tree species in Lithuania
4.	D.Danusevičius, V.Marozas	Lithuania	Spontaneous hybrids between *Pinus mugo* and *Pinus sylvestris* at the Lithuanian sea-side
5.	R.Iršėnaitė, J.Kasparavičius, E.Kutorga, S.Markovskaja, J.Motiejūnaitė, A.Kačergius	Lithuania	Recent new additions to the alien mycobiota in Lithuania
6.	V.Lygis, I.Vasiliauskaitė, R.Vasaitis	Lithuania	Xylotrophic fungi in plantations of alien pine species, *Pinus mugo*, subjected to various disturbances in Lithuanian coastal zone
7.	J.Motiejūnaitė, G.Adamonytė, M.Dagys, A.Kačergius, J.Kasparavičius, E.Kutorga, S.Markovskaja, D.Matulevičiūtė, A.Matusevičiūtė, D.Pečiulytė, R.Taraškevičius	Lithuania	Forest under impact of cormorant colony – plants, fungi, lichens, soil microorganisms and microarthropods
8.	J.Motiejūnaitė, G.Adamonytė, R.Iršėnaitė, S.Juzėnas, J.Kasparavičius, E.Kutorga, S.Markovskaja	Lithuania	Fungal community succession following crown fire in *Pinus mugo* stands and surface fire in *Pinus sylvestris* stands
9.	V.Stakėnas, K.Armolaitis, R.Buožytė, J.Aleinikovienė	Lithuania	Coarse woody debris: carbon and nitrogen contents and bryophyte diversity
10.	L.Straigytė, V.Baliuckas	Lithuania	Spread intensity and invasiveness of sycamore maple (*Acer pseudoplatanus* L.) in Lithuanian forests
11.	A.Vitas, T.Oszako, R.Pukienė, J.A. Nowakowska, K.Sikora	Lithuania	*Phytophthora* spp. in deciduous trees in Lithuania: preliminary results

Monday, May 21
10:15 – 12:00

Session 1
Air Pollution, Climate Change, and Forest Growth

Chair persons:
Andrzej Bytnerowicz and Elena Paoletti

Do recent changes in environmental condition favor the growth of Scots pine and Norway spruce trees in Lithuania?

Algirdas Augustaitis[1], Ingrida Augustaitiene[1]
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Implementation of Gothenburg protocols and other international legislation have led to significant reduction of the emission in Europe what could have stimulated forest condition recovery. Climate change, which in most cases is pronounced through the warming dormant period and re-distribution of precipitation amount also could have had additional effect on forest condition. Do these changes favor crown defoliation reduction and growth intensity is question which needs a very deep discussion. In the study we attempted to establish if the recent changes mainly in climatic condition could favor more intensive growth of two prevailing coniferous species Scots pine and Norway spruce trees in Lithuania. To meet the objective of the study in five experimental over matured stands across all Lithuania the biggest (overtopped) pine and spruce trees, diameter of which at breast height exceeded 40 cm were selected. We hypothesized, that growth of these trees best of all shows the effect of climate and air pollution. The effect of mean monthly temperature and amount of precipitation on tree ring linear and area increment was detected employing dendrochronological method. The obtained data revealed that growth reduction of over matured pine and spruce trees occurred following natural ageing process until 1980 – 1990. Since the beginning of 1990s the growth of the healthy over matured pine as well as spruce trees on most of experimental sites has increased. Preliminary results indicated that meteorological parameters are responsible for the current increase in increment of over-matured pine and spruce trees the age of which exceeds 130 and 100 years, respectively. The increase in stem increment (linear and square area) can be attributed to the warmer winter months (January – March) and precipitation amount of July – August, mainly of the previous year. Additional positive effect on tree growth intensity could have had the decrease in air concentrations of sulphur compounds and their deposition followed by decrease in precipitation acidity. However, insufficient data series on pollution level (20 year period) if compared with data on meteorological parameters do not allow concluding that the decrease in pollution level is more significant to intensive tree growth than that of changes in meteorology.

Impact of elevated atmospheric humidity on performance of silver birch (*Betula pendula*)

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The experiment was performed on saplings of silver birch (*Betula pendula* Roth) growing at the Free Air Humidity Manipulation site (http://www.lote.ut.ee/FAHM/in-english), which was established to investigate the effect of increased air humidity on tree performance and canopy functioning (Kupper et al. 2011). The aim of the experiment was to simulate impact of increasing atmospheric humidity on forest ecosystems, predicted for Northern Europe. Artificially elevated relative humidity (RH), which causes transpirational flux to decrease, diminished nutrient supply to the foliage − leaf nitrogen content (P=0.026), phosphorus content (P<0.001) and P:N ratio decreased (P<0.001). The changes in leaf nutritional status brought about a considerable decline in both photosynthetic capacity (A_{max}, V_{cmax}, J_{max}) and growth rate of the trees. The manipulation induced diverse changes in tree hydraulic architecture and other functional traits. Different segments of the soil-to-leaf water transport pathway responded differently: leaf hydraulic conductance (K_L) decreased, while hydraulic conductance of root systems (K_R) and leaf-specific conductivity of stem-wood (LSC_S) increased in response to elevated RH. Humidification caused Huber values of stems (HV_S) to increase, thus, reflecting changes in allocation patterns; relatively more resources were allocated to vascular tissue and less to foliage. The elevated RH induced substantial changes in specific leaf area (increased; P=0.009), branch- (decreased; P=0.018) and stem-wood density (decreased; P=0.001). The expected climate-change-induced increase in the growth rate of trees at northern latitudes (boreal areas) due to earlier start of the growing season in spring could be smaller or null if temperature rise is accompanied by a rise in atmospheric humidity.

Kupper P., Sõber J., Sellin A., Lõhmus K., Tullus A., Räim O., Lubenets K., Tulva I., Uri V., Zobel M., Kull O., Sõber A. 2011. An experimental facility for Free Air Humidity Manipulation (FAHM) can alter water flux through deciduous tree canopy. Environ. Exp. Bot. 72:432–438.

Responses of the radial growth of trees to climate change at the timberline in southeast Tibetan Plateau: Difference between the shade-tolerant and intolerant tree species

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Southeast Tibet is characterized by a cold and humid climate and a high diversity of forest types with the highest timberlines in the world. In order to examine the difference in climate response between the shade-tolerant and intolerant tree species, tree-ring width chronologies of Georgei fir (Abies georgei var. smithii) growing on the shady slope and Sabina saltuaria ((Rehd. et Wils.) Cheng et W. T. Wang) on the sunny slope at the timberline in the Sygera Mts. in southeast Tibet of China were developed. Both standard chronologies show significantly positive correlations with mean summer (June-August) temperature. The tree-ring width growth of Sabina saltuaria responded sensitively to recent warming observed in the instrumental record since 1961 with the last decade being the warmest period in the past 242 years, while tree-ring width of Georgei fir did not track such warming trend in southeast Tibet. In brief, at the timberline of Sygera Mts., the growth of Sabina saltuaria responds more sensitively to climate change than that of Georgei fir. Respective biological characteristics and habitat adaptation of both the tree species might result in the differences, implying the significance of tree species selection in paleoclimatic reconstruction.

Climate impacts on lodgepole pine (*Pinus contorta* var. *latifolia*) height growth in Latvia

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Lodgepole pine (*Pinus contorta* var. *latifolia*) is one of the few exotic tree species that has proven useful in Northern European conditions, combining straight growth with sufficient climate hardiness. Several growth features and wood properties of lodgepole pine surpass those of Scots pine which is the main native conifer tree species in Northern Europe. In view of the increasing demand for energy wood and timber, the use of this tree species in plantation forestry in Latvia could be considered. However, before any recommendations for the use of lodgepole pine in Latvian forestry can be made, scientifically-based knowledge about the relations between the tree growth and climate variables in Latvian conditions is essential. Several studies suggest that height growth is more suitable for examining the effects of climatic variations. Information about annual height growth of 297 lodgepole pine trees from three provenances in an experiment established in 1985 was used in this study. We analyzed the statistical dependence between the annual height growth and several climatic variables, both simple and combined. The influence of mean air temperature during various periods, as well as that of the precipitation amounts was studied in order to understand the climate impacts on lodgepole pine height growth. Also differences in height growth pattern and growth-climate relationships among the three provenances were discussed.

Annual tree ring CO_2 and environmental changes

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The effect of the atmospheric CO_2 increase on plants and, in particular, on forests has been studied for many decades already. The climate change (CO_2 increase and temperature rising) might lead a considerable growth intensification, but this is not the case often. We think that this can be clarified by studying the distribution of CO_2 in disc tree rings. We suggested a simple method and made an experiment to determine the trend of CO_2, contained in gas samples extracted under vacuum from disc tree rings in different conifers. The laser photoacoustic method was used to study the CO_2 content in every annual tree rings of fir (*Abies sibirica* Ledeb.), spruce (*Picea obovata* Ledeb.), Siberian stone pine (*Pinus sibirica* Du Tour), and Scots pine (*Pinus sylvestris* L.) tree discs taken from the forests near Tomsk, West Siberia and Siberian stone pine tree discs from the Altai Mountains.

In our opinion, the atmospheric CO_2 growth should annually change the concentration gradient between stem-contained and atmospheric CO_2 leading to a reduction of the rate of CO_2 diffusion from stem to the atmosphere and to a gradual buildup of stem-contained CO_2. The measurement results show that 1) the CO_2 content is indeed found to increase in disc rings and closely correlates with the growth of the atmospheric CO_2; 2) the CO_2 accumulation shows however a cyclic pattern; 3) the character of the annual CO_2 distribution changes around 1960 when the carbon isotope composition has abruptly changed in the atmosphere; 4) the CO_2 content recorded in the Scots pine disc rings is greater, the rings were narrower and vice versa.

The mass spectroscopy measurements of CO_2 carbon isotope composition ($\delta^{13}C$) provide an evidence that the studied CO_2 is not supplied from the atmosphere, but rather belong to the tree itself.

Monitoring, surveying, modeling and mapping to detect ozone effects on forests in Trentino (Italy) - the ozone EFFORT project

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Ozone phytotoxicity has been widely investigated, with different experimental approaches and considering different response indicators and vegetation types. Nevertheless, with few exceptions, quantitative information on potential and actual effects on forests is scarce in Italy, due to limitations related to ozone data and systematic investigations.

On the basis of reported exceedances of ozone critical levels for vegetation in Trentino (North Italy, 347.000 ha of forests), in 2007 a 5-year study was started aiming to understand the actual levels of ozone in forest and the real impact on forest vegetation.

The project - based on the integration and analysis of measures, models, forest monitoring and inventory data - was planned according to different, complementary steps:

- measurements of ozone concentrations with passive samplers, systematically located on 15-21 forest sites;
- modeling (i) to estimate ozone concentrations and exposure (AOT40) with a 1x1 km resolution and (ii) to estimate the ozone stomatal flux for one test site and over a 15-years period;
- assessment of ozone-specific leaf injury, through investigations on *ad-hoc* introduced bioindicators and on native species;
- evaluation of non-specific effects, based on a correlative study between data on growth and health of forest trees (UN ECE Level I and II forest monitoring sites) and levels of ozone.

Results in terms of ozone concentrations, exposure, uptake, injury on woody species and relationship between ozone, environmental factors and tree health and growth will be presented.

Ecological indicators of global change: what do they tell us about the air pollution and climate change in the south of Portugal?

Cristina Branquinho[1], Pedro Pinho[1,2], Paula Matos[1], Alice Nunes[1], Sofia Augusto[1], Cristina Máguas[1]

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Global change drivers that at present time most affect forest ecosystems are: climate change, nitrogen pollution and chemical pollution. Southern Portugal has a Mediterranean climate and forest ecosystems cover more 30% of the territory. Moreover most of the forest in the south of Portugal has an important economic return since it is managed by man in particular in *montado* systems dominated by *Quercus suber*. The climate change in this region is anticipated to increase temperature and decrease precipitation or at least change the temporal pattern of precipitation events. Ecosystem functioning is extremely complex and thus monitoring the effects of environmental change factors in forest ecosystems in an integrative perspective can make use of ecological indicators. To evaluate the impact of those global change drivers in forest ecosystems we make use of ecological indicators: i) based on functional diversity and based on their potential to accumulate pollutants, biomonitors. We will use vegetation and lichen functional groups (that have traits such as tolerance to drought and water use efficiency) as potential ecological indicators of global change. On other hand we will use biomonitors to identify the pollutants mixture and their concentration in several case studies developed in the south of Portugal. Climate change was assessed over time since 1940 in a retrospective study in one of the driest areas of Portugal. Moreover, ecological indicators based on functional diversity of lichens and herbaceous vegetation were used in spatial/temporal climate gradients. Atmospheric pollution due to nitrogen (NH_3 and NO_x), sulfur and PAHs were assessed in relation to their potential sources. We identify which forest areas are more prone to be affected by those global change factors.

Acknowledgements to FCT-MEC (PTDC/AAC-CLI/104913/2008, SFRH/BPD/75425/2010)

Environmental Air pollution monitoring and measurement using Wireless Sensor Networks

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Air pollution has become a matter of global concern, particularly in some of the world's largest cities. It has been aggravated by developments that typically occur as countries become industrialized. The U.S. Environmental Protection Agency (EPA) designates a standardized air pollution level indicator, the Air Quality Index (AQI), which mainly consists of carbon monoxide (CO), nitrogen dioxide (NO2), particulate matter (PM), carbon dioxide (CO2) and sulfur dioxide (SO2). These pollutants affect human health and the environment at levels from local to global. To this end, an Environmental Air Pollution Sensor Network System (ENAPOSENS) for air pollution monitoring has been designed, implemented, and tested. This system consists of a Mobile Data-Acquisition Unit (Mobile-DAQ) and a Pollution Monitoring Server. The Mobile-DAQ unit integrates a microcontroller, air pollution sensors array and a data transmission or storage array. The Pollution-Server is a high-end personal computer application server with Internet connectivity. The Mobile-DAQ unit gathers air pollutants levels (CO, CO_2, O_3 and PM). The data could be stored to a memory card for further processing or serially be transmitted to the Pollution-Server. A database server is attached to the Pollution-Server for storing the pollutants level for further usage by various clients such as environment protection agencies, vehicles registration authorities, and tourist and insurance companies. The Pollution-Server is interfaced to Google Maps to display real-time pollutants levels and locations. The system which was successfully tested in the campus and the city reports real-time pollutants level and their location on a 24-h/7-day basis and enables users or decision-makers in calculating the Air Quality Index of the measured area. Thus, the experimentation carried out using the developed wireless air pollution monitoring system under different physical conditions show that the system collects reliable source of real time pollution data and the possible implication of the affected area.

Notes

Notes

Monday, May 21
13:00 – 14:45

Session 2
Atmospheric Deposition, Soils and Nutrient Cycling

Chair persons:
Mark Fenn and Jesada Luangjame

Nitrogen air pollution: decline and recovery of Scots pine (*Pinus sylvestris* L.) forest ecosystems

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Acute negative effects of air pollutants (mainly NO_x and NH_3, to a lower extent, – SO_2 and mineral dust) on the forests with a prevalence of Scots pine (*Pinus sylvestris* L.) on *Arenosols* were observed in the vicinity of a large nitrogen fertilizer plant JV 'Achema' (formerly "Azotas"). Initially, a continuous increase in the cover of nitrophilous ground vegetation (*Rubus idaeus* L., *Epilobium angustifolium* L., *Festuca ovina* L. etc.) along with the stimulation of Scots pine stand growth were detected. Afterwards, the growth inhibition, defoliation and, even, stand death started increasing. The decline of Scots pine stands was followed by the soil acidification caused by the accumulation of N and S compounds (increased content of Al^{3+}, accelerated leaching of base cations, etc.), as well as soil microbiota changes (increase in abundance of ammonifiers and micromicetes) and lasted for 15 years. Over the last 20 years nitrogen air pollution decreased almost to the background level. However, the decrease of defoliation in Scots pine stands began only 6-7 years after the reduction of air pollution. The recovery of acidified forest soils was more inert and started 3-4 years later than the decrease of defoliation. Meanwhile, ground vegetation remained degraded although the reduced number of nitrophilous plants was recorded.

Acknowledgement. This research was funded by SC "Achema".

An increasing trend in nitrate concentration in soil percolation water in a Norway spruce stand under low nitrogen deposition in Finland

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The aim of this presentation is to report the trends in pH and NO_3-N in soil percolation water in Finnish stands under intensive forest monitoring. In Finland, soil percolation water quality has been monitored since 1996 on 12–18 plots located on Norway spruce, Scots pine and silver birch stands as a part of ICP Forests Level II Programme. Soil percolation water has been collected at 2–4-week intervals during the snow-free period using zero tension lysimeters. Five lysimeters have been located at three depths: 5, 20, 40 cm below the soil surface. Percolation water samples were analyzed monthly for pH, NH_4-N, NO_3-N, SO_4-S, base cations and aluminium. In general, no dramatic changes or strong trends could be found in pH values during the monitoring period. However, some of the plots showed a weak decreasing trend in pH. This decrease is most probably related to the natural acidification due to aging of the tree stand. The NH_4-N and NO_3-N concentrations were generally very low, with few exceptions. A spruce plot located in central Finland (nr. 11, Juupajoki) showed a steadily increasing trend in NO_3-N concentration still in the depth of 40 cm despite the relatively low N deposition (ca. 300 mg m^{-2} a^{-1}). The relationship between nitrate leaching and the condition of the tree stand is discussed.

Nitrogen deposition and Critical Load exceedance: effects on health, growth and diversity of forest vegetation in Italy[1]

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Concern about the actual and potential effects of Nitrogen (N) deposition on forests embraces almost all the forest ecosystem's compartments, including vegetation, soil biota, soil and soil solution, and run-off. Particular emphasis was put on the role of N as a: (i) factor stimulating growth, thus enhancing Carbon uptake; (ii) possible cause of nutritional imbalance, thus causing possible problems with tree health because of altered susceptibility to pests and disease; and (iii) factor altering the composition and richness of ground vegetation.

In the frame of the Italian forest monitoring programme CONECOFOR, a study was undertaken to investigate the effect of actual N deposition and exceedance of N Critical Load (CL) on forest vegetation at selected forest ecosystems spread across a range of environmental condition and deposition loads. At these plots atmospheric deposition have been measured over the past 15 years together with a suite of other variables, including meteorology, ozone, soil- and foliar nutrients contents, species diversity, tree health and growth.

The study was conducted as follows: firstly, the Simple Mass Balance (SMB) method was used to estimate CL and calculate exceedance with respect to the actual deposition load; secondly, a set of predictors and response variables was identified. Thirdly, sub-sets of predictors were used to investigate effects of N deposition on the nutritional status of the plots and to model the response variable of interest; finally, the model's residuals (modeled-measured) were investigated with respect to N deposition values and CL exceedance.

Results of this study will be presented in terms of N deposition, CL exceedances, and estimated effects on tree health, growth and species diversity.

The initial part of this study was funded under the Life+ FutMon project (LIFE07 ENV/D/000218)

Effect of mineral fertilization on soil enzymatic activity of spruce younger age classes in the Beskid Śląski and Żywiecki Mts.

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The study was carried out on the basis of the experimental space founded in mid-montane zone (altitude of 900-950 m above sea level) using structured blocks. Research was carried out in triplicate with the the whole surface fertilization of soils spruce younger age classes (20-40 years) by grated serpentinite in combination with mineral fertilizers (NPK). In autumn 2008 on 1 are plots 10x10 m in size in the triplicate were manually sown grated serpentinite (S) in the quantity of 4000 kg ha-1 and 2000 kg ha-1 respectively on the haplic arenosol in the Beskid Slaski - subjected to the large impact of industrial pollution and on the haplic cambisol in the Beskid Żywiecki - in a moderate deposition of pollutants. In spring 2009 ammonium nitrate (N) in the amount of 150 kg N ha-1, triple superphosphate (P) in the amount of 80 kg P ha-1 and sulphate of potassium (K) in an amount of 110 kg K ha-1 were sown manually. The following variants of fertilization were used: C - control without fertilization, S-serpentinite, SN - serpentinite plus ammonium nitrate, SP - serpentinite plus triple superphosphate, SNP - serpentinite plus ammonium nitrate plus triple superphosphate and SNPK - serpentinite plus ammonium nitrate, triple superphosphate plus sulphate potassium. Soil samples were collected for testing in mid-August in the years 2009 - 2011 of the first three levels (A, AE or AB and B) to 30 cm depth. The activity of dehydrogenases, urease, β-glucosidase, and phosphatases was determined. Effect of applied fertilization variants on the activity of enzymes analyzed by non-parametric test of Kruskal - Wallis. A significant effect of fertilization on enzymes activity was found in the years 2010 and 2011. An increase as well as inhibition of enzymes was noted, depending on soil type, dose of serpentinites, variant fertilization and genetic level of soil, volume of deposition of pollutants.

Nutritional status of *Quercus* dominated forest ecosystems for Biomass production

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Forest Biomass is seen as a key source for clean energy and as a raw material for industrial processes to combat climate change. Unlike fossil energy sources, Biomass has relatively low energy contents per volume unit, leading to increased demands near to potential customers. We studied nutrient pools in deciduous *Quercus* dominated forest ecosystems which are located near to the capital of Austria, Vienna. Recently, biomass potentials as well as consequences of biomass extraction gained increasing scientific attention at these forest sites. The studied forest ecosystems are embedded in an area intensively used for agriculture and relatively fertile soils (Haplic luvisols, chernozems) and receive considerable amounts of nitrogen through aerial deposition (7.6-9.4 kg ha a^{-1}). Our aim was to assess the current nutritional status of the forest in order to determine the effects of increased biomass extraction, specifically of nutrient-rich compartments such as foliage, thin branches and twigs and bark which are typically left on site under current forest management practices. Preliminary results show that there is a good logarithmic correlation between the wood diameter and the wood/bark mass ratio, typically ranging from around 1 at d=3mm for all species to 5 at d=10mm for *Quercus petraeae* and 5-6 at d~15mm for main understory species such as *Carpinus betulus* and *Corylus avellana*. In general, foliage had the highest contents of macronutrients N, P and K for all species followed by regenerative compartments, bark and wood. In general, *Q. petraeae* had the lowest macronutrient contents of P and K. In case of N, *C. avellana* has slightly lower contents as compared to the other species. Based on this results, and soil nutrient pools and deposition rates, we will evaluate the biomass production capacities and develop forest management guidelines aiming at sustainable biomass production.

Water Migration of Organic Carbon and Nitrogen in Old-aged Spruce Forests of the Middle Taiga Subzone

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Aim of the research was assessment of dissolved organic carbon and nitrogen dynamics with stand throughfall and percolation soil water in system atmosphere-phytocenosis-soil in old-aged spruce forests as conditionally background site. Our studies were conducted in three Siberian spruce plots in the middle taiga subzone (N 62°17′, E 50°40′). Samples of precipitation, throughfall and lysimetric waters were collected once a month from 2005 to 2010. The methods of chemical analyses were thermocatalytic oxidation/chemoluminescence (dissolved organic nitrogen (DON)) and thermocatalytic oxidation/NDIR (dissolved organic carbon (DOC)). Total content of ions in crown deposition had always low values. DOC dominated in composition of water samples with a great variation (40-84 %). Snow throughfall samples contained from 0.04 when taken from forest canopy "windows" to 35.1 mg l^{-1} organic carbon under spruce crowns, and from 0.04 to 0.60 mg l^{-1} organic nitrogen. Values of DOC and DON in snow samples increased during thawing periods. Depending on vegetation period, concentration of organic carbon in wet throughfall deposition varied from 2.2 to 109.2 mg l^{-1} and that of nitrogen – from 0.1 to 3.6 mg l^{-1} under spruce. The highest magnitude of DOC was detected in July and September and that of DON – in August. Rainfall waters in "open area" contained less DOC and DON than throughfall sampled under spruce crowns. Soil waters in spruce forests were characterized by a relatively high DOC content. Its concentration in percolation from soil litter waters remained high throughout the observation period (DOC from 17 to 277 mg l^{-1}, DON from 0.4 to 3.6 mg l^{-1}). Organic matter was weakly leached out from mineral soil horizons: DOC 10-138 mg l^{-1}, DON 0.4-1.8 mg l^{-1}. Thus, the dynamics of organic carbon and nitrogen contents in atmospheric precipitation and soil waters in old-aged spruce forests is largely affected by the phytocenosis.

Effects of Cruise Ship Emissions on Air Quality and Vegetation in Southeast Alaska

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Increased tourism in southeast Alaska has raised concerns about the levels and ecological effects of air pollutants emitted by cruise ships in dock and in transit. Air quality monitoring of fossil fuel combustion emission products and heavy metals was conducted at several sites in the southeast Alaskan parks and wilderness areas and near the municipality of Skagway in summer 2008 & 2009 (the tourist seasons). Passive samplers were deployed to measure average weekly ambient atmospheric concentrations of NO_2, NO_x, HNO_3, NH_3 and SO_2, and ion exchange resin tube samplers were deployed to measure seasonal bulk and throughfall deposition of nitrogen and sulfur. Atmospheric concentrations of air pollutants, deposition, and concentration of some elements, including sulfur, lead, zinc, and vanadium, in lichen tissue samples near Skagway's ship docks were considerably elevated above background levels. The relatively high levels of S deposition near Skagway correspond to the S signal in lichens. Sulfur levels associated with adverse effects to sensitive plants were primarily observed in lichens within 2 km of Skagway. There is evidence that species richness of lichen communities increased with added N due to the addition of more mesotrophs and eutrophs to the communities. In general, as the distance increased from human activity centers, levels of pollutants declined. Most sites exhibited pristine or global background condition as expected for rural southeast Alaska. Occasionally, weekly average ambient concentrations of nitrogen and sulfur containing compounds were elevated, probably due to atmospheric conditions during those weeks. Unusual elevated spikes in NH3 were detected at several sites. Although greater trans-Pacific emissions associated with industrial expansion and energy production in Asia and more wildfires emissions from northern Alaska/Canada contribute to background regional nitrogen oxide levels, nitrogen accumulated by epiphytes did not increase significantly over the past ten years except near local, seasonal sources of pollution.

Trends in nitrogen deposition in Spain: comparison of measured and modeled data

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Emissions of atmospheric nitrogen (N) compounds in Spain have increased from 1990 to 2007. Total annual estimates of N deposition loads in Spain are 10-20 kg N ha^{-1} yr^{-1} (Rodà et al., 2002; Avila et al., 2010). These values are lower than values recorded in central Europe, both measured and modeled data. However, since changes in species composition occur early in the sequence of N saturation, N deposition effects could be occurring in Spanish natural ecosystems. These effects could be particularly important in this Mediterranean area, considered as a hotspot for biodiversity. Therefore, suitable estimations of N deposition are needed to detect those areas where air pollution effects could be occurring

Air quality models constitute a valuable tool to quantify air pollution over broad geographic areas. In this work, we compare N deposition estimates obtained with two air quality models, EMEP v 3.8 and CHIMERE V200603par-rc1 version, with measured values obtained in different monitoring networks. The measured values considered were: bulk deposition data of the 14 ICP-Forest Level II plots located in Spain; wet-only deposition data of the 10 Spanish sites of the EMEP monitoring network; wet-only precipitation collected at 4 sites of the regional air pollution network in Catalunya (NE-Spain) and at the long-term biogeochemical study site of La Castanya (Avila et al., 2010). The monitoring site locations were matched with the corresponding EMEP grid (50x50 km) and CHIMERE grid (20x20 km) cells. Measured annual bulk deposition or wet-only deposition values of NO_3^- and NH_4^+ were compared to wet deposition data obtained with the models for the period 2005-2008. Temporal trends were analyzed using measured data for the period 1997-2008. Differences in N deposition estimations between air quality models and between models and measured data will be discussed.

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Notes

Notes

Monday, May 21
15:15 – 17:00

Session 3
Forest Health, Methods and Tools for Forest Monitoring

Chair person: Marcus Schaub,
co-chair Algirdas Augustaitis

Measurements of stomatal ozone fluxes and effects in a mixed mediterranean oak forest

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Continuous measurements from September 2011 to February 2012 were carried out in a mixed Mediterranean forest located inside the Presidential Estate of Castelporziano, Rome, central Italy, composed by *Quercus ilex*, *Quercus suber*, *Pinus pinea*, *Laurus nobilis*, *Arbutus unedo*. The main goal was to perform an investigation of fluxes of ozone, water and CO_2 with the Eddy Covariance technique in order to 1) quantify ozone deposition to the forest canopy and characterize its dependence on stomatal and non-stomatal drivers, 2) predict ozone effects on NEP (Net Ecosystem Productivity). The study highlighted the forest canopy as a relevant ozone sink, with total ozone fluxes up to 10 nmol m^{-2} s^{-1} during the central hours of the day. Stomatal conductance was calculated by inversion of the Monteith equation through available water fluxes and meteorological parameters. Results show that stomata are a minor sink for ozone, contributing up to 15 % to the total ozone flux. Low levels of stomatal conductance can be explained by drought stress in the warm days of September and October, while the cold days affected the phenology of trees thus limiting the stomatal conductance. Current efforts are in performing statistical analysis using a step forward approach and various predictors of NEP.

Acknowledgments: We are grateful to the Scientific Committee of the Presidential Estate of Castelporziano and to its staff, in particular to Ing. Aleandro Tinelli, for the scientific and financial support. Thanks also to the EU project Marie Curie-IAPP “Innovative Application of PTR-TOF mass spectrometry in plant biology (PTR-TOF)”, the EU EXPEER project (GA no. 262060), and the UE LIFE project (ENV/FR/000208) for financial help. We finally want to acknowledge Roberto and Valerio Moretti and Filippo Ilardi for helping with the maintenance of the experimental site.

Ozone fluxes to a larch forest ecosystem at the timberline in the Italian Alps

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Two years of ozone flux measurements were made over a larch forest ecosystem in the Italian Alps under an EU Interreg IIIb project of the Alpine Space programme named MANFRED (Management strategies to adapt Alpine Space Forest to climate change risk). The forest were located on a slope at 1750 m a.s.l., just at the timberline of the Camonica Valley, and is a secondary *laricetum* with grass as understory vegetation.

The measurements were taken at the top of a 30 m tall tower by means of the eddy covariance technique from June to September each year. Concurrent measurements of water and heat fluxes, as well as of common meteorological parameters, have been taken too.

In order to calculate the ozone amount received by the ecosystem vertically from the atmosphere, the wind vector measurements - taken in a reference system where the vertical z-axis were directed toward the zenith (the vertical lead wire) - have been expressed in a rotated reference system where the vertical z-axes were directed normally (perpendicularly) to the slope, according to the prevailing wind direction.

Then, ozone fluxes has been partitioned into a stomatal and a non-stomatal parts by means of an energy budget method based on the derivation of the bulk stomatal conductance from the water fluxes through the inversion of the well known Penman-Monteith equation for evaporation.

Results revealed unexpectedly high ozone stomatal fluxes, accounted around 70 mmol m^{-2} for a 4 months growing period ranging from June and September. But the total ozone amount received by the ecosystem was even higher, around 155 mmol m^{-2}. As a consequence the non-stomatal ozone deposition on the non-transpiring plant surfaces and soil resulted on average the 55% of the total ozone flux.

While the ozone concentrations daily course was reversed (i.e. shows the minimum ozone concentration at midday) since the forest lay mainly in the free troposphere, the stomatal ozone fluxes followed an opposite course with a maximum around 15 nmol m^{-2} s^{-1} reached at noon and sustained until late afternoon.

For comparison reason, the ozone exposure assessed according to the currently EU in force standard - the AOT40 calculated on ozone concentration measured at the top of the canopy from 8 a..m. to 8 p.m. - resulted about 30'000 ppb.h.

In literature no dose-effect relationships have been reported for larch. The UN/ECE mapping manual (2004) indicates that a critical ozone phytotoxycal dose (POD1) of 8 mmol m^{-2} causes a biomass reduction of 2% in Norway spruce, the only conifer considered. If a similar dose-effect relationship was applied to larch, for our larch ecosystem, at the observed ozone dose (POD1 around 60 mmol m^{-2}), one would have to expect about 15% of reduction in the overall plant biomass production.

Forest Monitoring - assessment, analysis and warning system on forest ecosystem status

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The well-functioning and the health status of the forest are highly influenced by multiple and concurrent interactions of different stress factors, i.e. air pollution, climate change, biotic agents, land use change, poor management.

The effectiveness of the main ecological, social and economic functions of the forest can be properly induced as long as the health status, stability and continuity of the forests are protected by means of sustainable management.

In order to identify, analyze and monitor the declining or adaptation processes of forest ecosystems, it was established a system of methods and techniques of continuous observation and control over the main factors that potentially have an influence on forests, i.e. the forest monitoring system.

The main features of the forest monitoring system are common to all ICP-Forests members, and are based on the objectives, strategy and implementation of CLRTAP agreement.

In the framework of ICP-Forests monitoring activity, Romania’s forest have been generally graded as moderately affected, except 1993-1994, when the percent of damaged trees (defoliation more than 25%) was larger than 20% (20,5% in 1993 and 21,3% in 1994. The broadleaves were more affected compared to the conifers (percent of damaged trees was 9,3% in 2005 – 22,9% in 1994 and 4,7% in 2005 – 16,6% in 1993, respectively), but nevertheless the forest health status did not change significantly. The European beach and Norway spruce are the less affected species and largely stable over the analyzed period (5,2% in 2006 – 15,1% in 1994 and 4,0% in 2005 – 15,3% in 1993, respectively).

Particularly, in the South and South East regions of Romania, it has been found a higher intensity of the damaging factors, and considering the climate change predictions it is utterly important to reconsider the importance of the forests in this regions, as a living barrier against the Eurasian steppe expansion.

The ectomycorrhizal fungi in declining pedunculate oak (*Quercus robur* L.) stands

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Pedunculate oak (*Quercus robur* L.) is critically dependent on ectomycorrhizal (ECM) fungi for optimal growth and development. Large scale oaks decline observed from 1980s has become a worldwide problem. The aim of presented research was to describe the ECM species richness and composition of declining oaks and determine the relationship between the functional diversity of ECM fungi and crown defoliation level.

We investigated the ECM community composition of mature pedunculate oak trees in three declining stands of Krotoszyńskie Forests considered as the largest oak forests in Poland. Soil cores were sampled from oak trees showing 25-99% level of crown defoliation. Additional samples from dead trees were taken as well. Molecular approach based on PCR and sequencing of the ITS rDNA were performed to identify ectomycorrhizas.

Forty two ECM fungal taxa associated with declining oaks have been recorded. Among them *Cenococcum geophilum* and *Lactarius quietus* were the most frequent and abundant taxa. Also Tomentelloid fungi were widespread in analysed stands. We identified several taxa that rarely occur in Poland (e.g. *Melanogaster ambiguus*, *Tuber maculatum, T. puberulum*, *Tomentella punicea*, *T. lapida*). The lowest number of ECM fungal species richness were noted for oaks with high defoliation level. We presume that crown defoliation level and as a consequence limited carbon flux from crown to roots may affect belowground ECM community composition.

Growth peculiarities of European beech trees on the edge of their distribution range in north-eastern Europe

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European beech seems to be a successful tree species outside its distribution range in the north-eastern part of Europe. Prussian foresters promoted European beech in the western and south-western parts of Lithuania in the nineteenth century by planting these trees in Scots pine stands. This forest management practice ensured beech migration towards north-east, what resulted in arising of the new issues concerning sensitivity of European beech to current environmental changes, in areas outside their natural distribution range. The selected beech stands are located from the north-eastern part of Poland to the Western part of Latvia, and from the sea side to the eastern part of Lithuania. Dendrochronological analysis was employed to detect sensitivity of beech trees to unfavorable climatic conditions – frost over the dormant period and drought over – vegetation. The obtained data revealed that the positive effect of warmer dormant period and precipitation amount over the vegetation favoured moving from west (sea side) to east – south-east of the country. At the most eastern location the lack of humidity (precipitation amount) in winter months and middle of vegetation (May-July) as well as lower temperature over dormant period, especially early spring (March), and middle of vegetation (July – August) limited formation of tree ring width of beech trees. In the western part of the country only precipitation amount over the vegetation had a direct effect on tree ring width, meanwhile higher temperature from July through September depressed radial growth of the beech trees. Controversial results were obtained on the sea side part of the country. More abundant precipitation and higher temperature resulted in tree growth reduction. Based on recently detected trends in precipitation and air temperature changes we can conclude that eastern part of Lithuania is becoming more favorable for beech tree growth what is very well illustrated by significant increase in tree ring width since the very beginning of 1990s.

Role of scale predator *Anthribus nebulosus* in control of population of *Physokarmes piceae* Schrnk. in Norway spruce *Picea abies* (L.) Karst. Ecosystems

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Significant defoliation caused by unknown source were identified between 2007 and 2010 in the Norway spruce *Picea abies* (L.) Karst. stands in North-eastern part of Poland, Lithuania and Latvia. In Latvia these damages distributed rapidly in spring and beginning of summer of 1010. Characteristic indications of the damages were small increments of new shoots and brownish colour of tops or the whole crown of spruces. The defoliation first appeared at a top of trees and then distributed downward. The most of the trees which lost more than 60 % of foliage during beginning of summer diseased until the end of the year. Considerable increase of population of the spruce bud scale insect *Physokarmes piceae* (Schrnk.) was observed in damaged stands. Notably, that considerable growth of population of spruce bud scale was observed in autumn of the same year in young spruce stands located nearby to the stands damaged earlier in summer. Such damages were not observed earlier in Latvia; however, no hysterical data on population of the scale insects is available.

The scope of the study was to evaluate the role of the *Anthribus nebulosus* in control of population of the bud scale. The rationale of the study is willing to utilize biological tools to control distribution of the pest in future. The biological control of pests works slowly, but after initialization they are able to control undesirable organisms for a long time. *Anthribus nebulosus* belongs to group of predators, which larva is feeding on insects of the *Physokermes* genus, including the scale insects. Characteristic indication of presence of the *Anthribus nebulosus* and reduction of population of the spruce pests is small holes in shells of the female scale insects.

Empirical material for evaluation of role of the *Anthribus nebulosus* in control of population of the bud scale insect was collected in six forest stands on moderately fertile drained peat soils (stand type – *Myrtillosa* turf. mel.). Two stands were located nearby Līvbērze, two – nearby Baldone, and one – nearby Plakanciems and Dzelzāmurs. Average height of trees was less than 3.5 m. Circular sample plots with radius 2.82 m were established to count number of *Anthribus nebulosus.* In total 41 sample plots with total area of 1025 m^2 were established. The largest number of shells of the female bud scale insects was identified in the lower part of crowns ($N_{vid} \pm s$; $\alpha = 0{,}05$) 64 ± 84,2, in central part – 54 ± 71,4 and the smallest number of the shells on top of trees – 3 ± 4,8. The largest number of the bud scale insects were found in mixed spruce stands, where the silver birch (*Betula pendula* Roth.) trees were distributed equally across the stand and birch trees were at least 1 m higher than spruces, which means that admixture of deciduous trees do not reduce risk of the damages. Strong positive correlation was identified in the study between the number of shells of the bud scale insect females and distribution of the *Anthribus nebulosus* in the stand ($r = 0{,}927$, $p<0{,}05$). This confirms that natural enemies of the bud scale insect can successfully follow to dynamics of distribution of the pest. It was also approved by evaluation of distribution of the bud scale insect in stands suffered from this pest one to two years after invasion – in the most of the stands no living pests were identified.

Leaf mass per area (LMA) contributes to the sensitivity of tree species to elevated ozone

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To assess the factors contributing to ozone sensitivity, we investigated eight subtropical broadleaf tree species (six evergreen and two deciduous native species) exposed to either charcoal-filtered air or elevated O_3 (E-O_3, ~150 ppb) for one growing season. Initial visible symptoms were observed in deciduous species when AOT40 value reached 10 ppm.h and in evergreen species when AOT40 value was more than 20 ppm.h. E-O_3 had an overall negative effect on the growth as indicated by significant decreases in shoot and root biomass as well as specific leaf mass. The species which first showed visible symptoms also had the largest reductions in biomass. E-O_3 induced significant reductions in light-saturated photosynthesis rate (A_{sat}), total chlorophyll content and total antioxidant capacity, while significant increase in MDA content in two deciduous species and two evergreen species (*Cinnamomum camphora* and *Cyclobalanopsis glauca*). Except *C. glauca*, however, E-O_3 had no significant effects on stomatal conductance (g_s), total phenols and ascorbate contents. Across eight species investigated, AOT40 values at initial symptom onset showed significantly negative correlations with E-O_3-induced reductions in total biomass, A_{sat} and total chlorophyll content. Difference in O_3 sensitivity among all species was strongly attributed to leaf mass per area (LMA) rather than g_s or antioxidant levels, suggesting that functional LMA contributes to the sensitivity of tree species to elevated O_3 concentration.

Notes

Tuesday, May 22
8:00 – 9:45

Session 4
Dedicated to Satu Huttunen

Chair persons:
Sirkku Manninen and Allan Legge.

Nitrogen and sulfur air pollution and atmospheric deposition in the Athabasca Oil Sands Region, Alberta, Canada

Andrzej Bytnerowicz and Mark E. Fenn
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The risk of negative effects of emissions of industrial air pollutants in the Athabasca Oil Sands Region (AOSR) increases as the area of the exploited oil sands and rate of bitumen production expand. Therefore ambient concentrations of air pollutants of biological importance (NH_3, NO_2, HNO_3 and SO_2) have been monitored with passive samplers as monthly averages since 2005 on a network of 38 sites. The sum of inorganic gaseous reactive nitrogen (N_r sum) was calculated as the combination of HNO_3, NH_3 and NO_2 and ranged from 1.0 to 6.1 µg m^{-3} in winter and 0.9 to 3.4 µg m^{-3} in summer. Highest N_r sum levels were driven in winter by NO_2 concentrations and in summer by both NO_2 and NH_3. Sulfur dioxide levels reached 8 µg m^{-3} in the AOSR center. In addition, atmospheric N & S deposition has been monitored with ion exchange resin collectors for summer and winter seasons on a network of 16 sites. Nitrogen deposition in throughfall across the sampling network ranged from 1.3 to 24.8 kg ha^{-1} yr^{-1} and sulfur deposition ranged from 3.1 to 39.2 kg $ha^{-1}yr^{-1}$. Deposition declined sharply with distance from the industrial center. Deposition of NH_4 was generally greater than NO_3 deposition, particularly in summer. Bulk deposition of N and S in forest clearings ranged from 1.4 to 6.1 and 1.3 to 11.7 kg $ha^{-1}yr^{-1}$, respectively. Although levels of the measured pollutants do not indicate direct toxic effects to vegetation, sensitive communities such as epiphytic lichens are known to be affected at the reported NH_3 concentrations. Consequently, among the monitored pollutants, NH_3 seem to be of highest importance due to its high biological activity and high contribution to N deposition. Furthermore, in the most polluted areas, elevated levels of N and S deposition may have serious ecological consequences for forests and other ecosystems of the AOSR such as acidification and changes in nutritional status of vegetation.

Ambient ozone exposure affects carbon allocation and gas exchange in poplars treated with the antiozonant ethylenediurea for three years

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Tropospheric ozone (O_3) is an important phytotoxic air pollutant, whose long-term effects on forest growth are not well established yet. The antiozonant ethylenediurea (EDU, N-[2-(2-oxo-1-imidazolidinyl)ethyl]-N'-phenylurea) can be used as a tool for multi-year investigations in the field. We report results from a three-year experiment where EDU was applied as a soil drench to an O_3-sensitive poplar clone (Oxford, *Populus maximoviczii* Henry × *berolinensis* Dippel) in a central Italy site at high ozone exposure (AOT40 ≈ 26 ppm h).

Growth of EDU-protected trees was compared with that of water-treated trees. Differences in diameter and height were negligible. A marked shift in biomass allocation to roots and lateral branches occurred and determined a significant reduction in total biomass (-44%) due to ambient ozone.

EDU was also effective in reducing the extent of visible foliar injury. Leaves showing different degrees of ozone injury were used to study steady-state and dynamic stomatal response and assess whole-tree water loss and carbon assimilation. Steady-state stomatal conductance and photosynthesis linearly decreased with increasing ozone visible injury. Dynamic responses simulated by severing of a leaf revealed that stomatal sluggishness increased until a threshold of 5% injury and was then fairly constant. Sluggishness resulted from longer time to respond to the closing signal and slower rate of closing. Changes in photosynthesis were driven by the dynamics of stomata. Whole-tree carbon assimilation and water loss were lower in trees exposed to ambient O_3 than in trees protected by EDU, both under steady-state and dynamic conditions. Although stomatal sluggishness is expected to increase water loss, lower gas exchange and premature leaf shedding of injured leaves aggravated O_3 effects on the whole tree carbon gain, while compensating for water loss. On average, WUE of trees exposed to ambient ozone was 2-4% lower than that of EDU-protected control trees in September and 6-8% lower in October.

Direct interactions of hygroscopic particles with leaf/needle surfaces and plant water relations

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Air pollution and land use change have caused strong global and regional increases of aerosol concentrations throughout the last 200 years, compared to the long-term stability of background concentrations. Although leaf surfaces are a major sink for aerosol deposition, little is known about the direct interaction of deposited particles with leaves. The analysis of direct pollutant interaction with plants concentrated on trace gases, while evaluations of aerosol impact focused on element loads on the ecosystem scale. Direct interactions can result from the hygroscopicity of the deposited particles and their position within the humid leaf boundary layer. They loose their crystalline shape by deliquescence, they become chemically active and difficult to detect.

The detection of deliquescent leaf surface particles and their interaction with plant water relations was studied. Submicron particles were produced from different salt solutions by a particle generator, and were deposited to leaves and needles within a small wind tunnel. They were then detected using an environmental scanning electron microscope (ESEM), which also enabled changes of humidity during observation. Repeated deliquescence and re-crystallization of particles changed the optical appearance of the leaf surfaces. It was possible to trigger the transition from pristine filamentous to amorphous epicuticular waxes by switching between different humidities.

Gas exchange was measured for plants grown in normal and particle free air, and for plants treated with aerosols. The exclusion as well as the addition of particles caused differences in gas exchange, pointing to increased transpiration and decreased water use efficiency as a consequence of higher particle load.

These results are related to different types of forest decline, caused by air pollution, polluted sea salt, and global change type drought, respectively. Amorphous ‘degraded waxes’ might be a key factor, if they are produced by deliquescent particles rather than by changes in wax chemistry.

The impact of temperature and solar UV radiation on chlorophyll and phenolics of Sphagnum sp.

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Sphagnum mosses are a crucial component in numerous boreal and subarctic ecosystems. If dominant in the ground cover, peatmosses regulate nutrient flow, water regime, pH and temperature balance of the substrate. They affect species diversity creating specific growing conditions for plants and microorganisms. Little is known about the regulatory role of solar UV radiation for *Sphagnum*. In this research, we studied the synergetic effects of varying UV-B radiation and temperature on photosynthetic pigments (chlorophyll a and b) and UV-B absorbing compounds (phenolics) of *Sphagnum lindbergii*, *S. jensenii* and *S. balticum*. The research was based on a long-term field UV-B attenuation experiment in Northern Finland. The UV radiation doses and temperature conditions were regulated using plastic filters. Chlorophyll concentration was measured spectrophotometrically, and that of phenolic compounds by HPLC.

Each *Sphagnum* species expressed an individual pattern of seasonal changes in chlorophyll a and b concentration, as well as species-specific responses to simulated changes in the environment. Treatment effect varied within the growing season. The total concentration of chlorophyll was significantly higher in *S. lindbergii* and *S. jensenii* compared to *S. balticum*. In both *S. balticum* and *S. jensenii*, the concentration of chlorophyll a decreased towards the end of the growing season in all the treatments. In the dominating *S. lindbergii*, it had a tendency to increase in the end of summer in ambient and UV-B treatment, and to decrease in control conditions. The pilot HPLC analysis revealed higher concentration of phenolic compounds in air-dried samples of *S. lindbergii* compared to lyophilized ones.

Assimilation, acclimation and allocation responses of birch and aspen to increasing temperature and oxidative stress

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Understanding responses of plants to environmental factors is required in modeling and predicting changes of carbon sink strength of forests under different environmental conditions. Carbon cycling rates are influenced by the net carbon assimilation, changes in plant morphology, as well as allocation of carbon within trees. Biomass allocation and chemical allocation occur simultaneously, and are closely connected processes. Considering the whole-plant responses to environmental factors is therefore necessary for predicting long-term effects on forest ecosystems. Here, the responses of young deciduous trees to increasing air temperature in interaction with tropospheric ozone, and responses to special effects of night-time temperatures are examined.

A field experiment with warming and elevated ozone, and a chamber experiment with night temperature treatments were conducted for birch (*Betula pendula*) and aspen (*Populus tremula*). The results indicated that rising air temperature increases plant level net photosynthesis through increasing total leaf area, and delays leaf senescence in autumn. The ozone-caused decrease in leaf-level photosynthesis was in part ameliorated by warming. On the other hand, the efficient stomatal adjustment to warming climate was disturbed by ozone. The effects of warming and ozone appeared differently in different plant parts, which should be addressed in leaf and cell level analysis in complex environment. The findings underline the importance of whole-plant perspective also in leaf-level measurements. Acclimation to different night temperatures caused changes in plant height and biomass allocation towards stem growth in warmer nights. In addition, changes in volatile compound emissions e.g. due to changes in night temperature, may have a large effect on atmosphere-biosphere interactions. Simultaneous analysis of volatile and non-volatile compounds elaborated the picture of plant's metabolic responses. In general, metabolite analysis can advance the understanding of the regulation of plant growth, phenotype and biomass allocation, as well as interactions with environment.

Single and combined effects of peroxides and ozone for consecutive three years on visible leaf injury, growth, and mineral content of beech seedling

Cattleya Chutteang[1], Ryota Marushima[1], Mayuko Takeda[2], Ge Zhenrui[1], Prathomrak Na-ngern[1], Buhe[1], Fumiaki Takemasa[1], Shiro Hatakeyama[1], and Masatoshi Aoki[1]

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Tropospheric ozone (O_3) has been increasing in the world and has contributed to decline of beech forests in Tanzawa Mountains, Japan. Peroxides always coexist with O_3 and harmful to plant when combined with O_3. Hence the objective of present research is to investigate the single and combined effect of peroxides and O_3 on visible leaf injury, growth and mineral content of beech seedlings. The exposure experiments were done for consecutive three years in 2009-2011. Exposure treatment plots were control plot (C plot), O_3 50 ppbv (O plot), O_3 50 ppbv+P 2-3 ppbv (OP1 plot) and O_3 50 ppbv+P 5-6 ppbv (OP2 plot). We found that the OP2 and OP1 plots showed more severe leaf injury and decrease in chlorophyll content than O plot in all years. These damages increased year by year. The winter bud volume per plant in OP2 and PO1 plots to C plot was slightly decreased in the second year and significantly decreased in the third year. Calcium, Mg, K, P, Na and Al in root of OP2 and OP1 plots were 2-4 times higher than of C plots. Potassium and P were very high in the shoot of OP1 and OP2 plots than C plots. Conversely, Fe of the shoot in OP1 and OP2 plots decreased into a half of C plot. It is concluded that the combined peroxides and O_3 caused more severe damage on visible leaf injury, decrease in chlorophyll content and growth rate than single O_3. The abnormality of mineral content in combined exposure plots might be the cause of increasing in damage of beech seedlings year by year.

Apportionment of Multiple SO_x and NO_x Source Emissions and their Deposition for Ecological Effects Assessment

Sagar Krupa[1], Matt Landis[2], Patrick Pancras[2], Eric Edgerton[3], Joseph Graney[4] Joel Blum[5], William Studabaker, James Raymer, R.K.M. Jayanty[6], Allan Legge[7], Kevin Percy[8]

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Alberta Oil Sands Region (AOSR), Canada, its oil reserves and the associated production represent one of the largest suppliers of oil in the world. Crude oil production consists of open pit mining, oil extraction and export. In addition to anthropogenic stationary sources of SO_x and NO_x, there are massive mobile sources and natural pollutant emitters such as forest fires. AOSR represents a boreal forest ecosystem. Much of the region has no ready access by land (only by helicopter) or to electricity. Therefore, we used the epiphytic lichen, *Hypogemnia physodes,* predominantly growing on pine species as a bio-indicator of the deposition and accumulation of S and N, some 43 metals, stable isotopes of Pb and Hg and poly-aromatic hydrocarbons (ICP/GC-MS) as tracers of air emissions for on-going terrestrial impact assessment. Initially spatial maps of S and N accumulation in the lichen were developed for locations up to some 130 km from the center of the emission source area, with sampling at sites distributed as a nested grid. Sites were identified as high and low S and N content or their ratios in the lichens. Subsequently, the metals and the stable isotopes were used to apportion the contributions of emissions from various sources. The US-EPA, Chemical Mass Balance (CMB) and the Positive Matrix Factorization (PMF) statistical algorithms were used for deriving the spatial relationships. This is the first study that combined the use of lead and mercury isotopes in lichens in an environmental forensics investigation. From a lichen sample collection and analysis standpoint, this is the largest multi-element, lead and mercury isotope database for an individual lichen species that has ever been assembled during a single sampling campaign. The results will describe the source apportionment of air emissions in the context of the use of plant bio-indicators of air quality.

Notes

Tusday, May 22
10:15 – 12:00

Session 5

Multiple Stressor Effects on Ecosystems

Chair persons:
Nancy Grulke and Mikhail Kozlov

(1st part)

Impacts of changes in climate, nitrogen deposition, ozone and CO_2 exposure on forest carbon sequestration: a meta-analysis

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Carbon sequestration in forests and forest soils is influenced by various drivers including changes in climate (temperature and water availability), nutrient (nitrogen, base cations, phosphorous) availability, carbon dioxide (CO_2) exposure and ozone (O_3) exposure. The combined effects of these drivers in forests and forest soils can either be synergistic (amplifying), antagonistic (dampening) or neutral (no interaction). To quantify the forests and forest soils response to single or interacting drivers, we conducted a meta-analysis of published manipulative field studies that reported above-ground C responses (above-ground net primary productivity-ANPP, leaf litterfall) and below-ground C responses (below-ground NPP, below-ground root litter, soil respiration) as well as total forests ecosystem CO_2 exchanges (NPP, net ecosystem productivity-NEP, net ecosystem exchange-NEE). We limited our study to boreal, temperate and Mediterranean regions particularly those in Europe, US and Canada. Data collection was limited to field experiments of at least one year, excluding data based on laboratory incubation or growth chambers, In total, results of 101 studies were compiled in a database and analysed. We used the site data on longitude, latitude, altitude and year to derive additional information on missing or unknown drivers, using the CRU climate database to assess mean annual temperature and annual precipitation and results of atmospheric deposition models to assess N deposition and an ozone measure such as AOT40 or phytotoxic ozone dose (POD). The quantitative synthesis of the data was done by a number of different effect size metrics including, the difference between treatment and control divided by the difference in conditions of the drivers between treatment and control. This metric is relevant to quantify responses to treatments, normalizing absolute responses to the magnitude of the treatment imposed. Results of the meta-analysis will be presented during the conference.

Multiple stressor effect analysis for future risk assessment of spruce forests in the Slezske Beskydy Mts. (Czech Republic)

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The method of risk assessment estimation of Norway spruce forest stand decay was verified in the Forest Enteprise Jablunkov. It consists in i) monitoring of tree health status on research plots and estimation of their adaptation potential; ii) statistical analysis of relationship between incidental cuttings and site conditions, including climatic factors of studied area (data from Forest Enterprise Plan and Forest Economic Evidence); iii) computation of risk assessment coefficients of forest stand decay on the basis of climatic normal and scenario data; iv) estimation of subsequent development of given forest stand in next 30 years using stress response module of growth simulator Sibyla (on the basis of risk assessment coefficients).

Monitoring of tree health status was realized on 193 research plots in two forest districts and on 18 semi-permanent research plots in five forest districts. Tree defoliation, crown structure transformation and occurrence of injurious agents were ascertained to estimate adaptation potential of forest stands. The most important site and stand characteristics and climatic parameters (frequency and intensity of temperature inverse in early spring, number of periods with minimally 10 days with precipitation < 1 mm and number of days with temperature > 30 C^{o} in growing period), influencing according to our opinion the occurrence of Norway spruce incidental fellings, were found using multidimensional analysis. Afterwards, risk assessment coefficients of forest stand decay (die back of more than 50% trees) was computed, based on selected site and stand characteristics and forest decline process. These coefficients were constructed for current climatic standard data and for data obtained from Aladin-Climate/CZ model for period 2010 – 2100. In addition, the subsequent development of typical forest stands in next 30 years was estimated by means of the stress response module of growth simulator Sibyla using risk assessment coefficients for current and climate change conditions.

Climate modifies effects of industrial pollution on growth of mountain birch

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In spite of high number of studies addressing impacts of both pollution and climate on woody plants, interactive effects of pollution and climate on plant growth remain almost unknown. We explored combined effects of weather conditions and pollution load on mountain birch (*Betula pubescens* ssp. *czerepanovii* (Orlova) Hämet-Ahti) by analyzing the results of long-term (1994-2010) measurements of leaf size and shoot length in 100 individually marked trees naturally growing at 20 sites located 1 to 65 km from the nickel-copper smelter at Monchegorsk (north-western Russia) in respect of monthly temperature and precipitation records at Monchegorsk.

Lengths of both leaves and shoots in heavily contaminated sites were on an average 80% of those in unpolluted sites. Stepwise regression analysis demonstrated that among-year variation in lengths of both leaves and shoots is best explained by mean temperatures of early spring (March-April): leaf and shoot size in unpolluted forests decreased with an increase in early spring temperature. However, for leaves the strength of this relationship (quantified by effect sizes based on correlation between leaf size and temperature) decreased with increase in environmental contamination (r = 0.50, n = 20 sites, p = 0.03). As the result, the differences in leaf size between birches growing in heavily polluted and unpolluted sites (effect sizes calculated as log-response ratios) decreased with increase in spring temperature (r = 0.52, n = 17 years, p = 0.03). Shoot responses to temperature were independent from the pollution level (r = 0.10, n = 20, p = 0.67).

Our results demonstrate that climatic conditions can modify effects of pollution on plants or, vice versa, pollution can modify plant responses to weather fluctuations. This result hints that (1) single-year data are insufficient to adequately measure effects of pollution and (2) interactions between pollution and climate should be accounted for in the analyses of global change impacts on biota.

Assessment of the reforestation success of fertilized cultures of *Fagus sylvatica* L. and *Abies alba* Mill. grown uder the canopy of spruce stands threatened with disintegration in the Beskid Śląski and Żywiecki Mts

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Experimental cultures, grown under the canopy of the stand and fertilized with natural aggregates: dolomite, magnesite and serpentinite, were set up in the middle forest zone (900 m a.s.l.) on 12 plots: 6 in each forest district (Wisła - highly threatened with disintegration and Ujsoły – under medium threat of disintegration). In each forest district, 3 large plots underwent full-surface fertilization (CP) while three others underwent point fertilization. Full-surface fertilization was applied in autumn 2008, point fertilization was applied in the spring of 2010. Planting were performed in spring 2010. On each of the three plots, beech and fir were planted: with the covered root system, mycorrhized (ZSK Mi), with the covered root system, not mycorrhized (ZSK), and with the open root system (OSK) - in 3 replications.

At the end of the vegetation period in 2011, the number of live plants was determined and then the percentage of survival was calculated. The number and characteristics of quality and health of seedlings were determined; the percentage of damaged saplings was calculated. These data were used to prepare preliminary assessment of the cultures of particular species of trees in accordance with the criteria applied in the Polish State Forests. In addition, the following features of each seedling were measured: height, height increment and root thickness in the neck.

In terms of survival and selected biometric features, the cultures of seedlings with the open root system (OSK) obtained a significantly lower assessment in comparison with the evaluation of seedlings with the covered root system, both with mycorrhization and without it. In both forest districts, a generally slightly better survival rate and the values of the assessed biometric features were observed for the CP method of fertilization. In the cultures of seedlings with the open root system (OSK), the examined parameters of seedlings measured in the control variant were, in both forest districts, generally significantly worse than in the fertilized cultures. No differences were found between the stands with varying degrees of the threat of disintegration.

Acknowledgement
This work was financed by the State Forests National Forest Holding in Poland within the project: 3/08 - *Forest management measures improving the growth, nutrition and health conditions in forest regeneration areas and endangered stands in the Beskidy Mts, with particular emphasis on soil revitalization with dolomites and new multi-component long-acting fertilizers*.

Response reactions of Norway spruce to changing air pollution and weather conditions in Kurzeme

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Air pollution and climate change is anthropogenic stressors that affect tree growth and forest productivity around the world. Environmental pollution that has been one of the key issues for decades has still not lost any of its topicality. In order to study the impact of air pollution on the growth of Norway’s spruce (*Picea abies* (L.) Karst.), 31 sample plots were established at different distances and directions from the pollution points in the Western part of Latvia. The plots were established starting from the year 2008 summer-autumn season and finishing with the spring of 2009. The selected stands were 32-171 year old and of different forest site types. The selection was used in the State Forest Service database and cartographic materials. Empirical data was obtained from each of the plots which reflected the environmental effects on the trees. To ascertain the effect of air pollution on the growth of Norway spruce, the algorithm based on additional increment of volume was used. Using the measurements of tree rings width, tree height and diameter at breast height, the stand’s additional increment is calculated with the method of I. Liepa (Liepa, 1996).

Norway spruce stands answers symptomatic of the forest stand, regardless of its age and forest site type is accumulating additional growth. Stock in addition to the increase in “D” transect ranging from 7.86 m3 ha-1 up -15.60 m3 ha-1 and the “Z” transect ranging from 2.79 m3 ha-1 up -21.37 m3 ha-1. Foster reaction depends on the distance to the sources, as well as the stand age. In addition to these indicators should be assessed in the spatial arrangement of trees in nature in order to assess any additional factors that influence the pace of growth in certain formations.Air pollution affects eating, regardless of age and the type of growing conditions.

Evaluation of the potential of sequestration of atmospheric carbon in a Portuguese eucalypt stand under conditions of water stress

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This work presents results of measurements made by eddy covariance methodology, between the years of 2002 and 2010, of carbon uptake and evapotranspiration in the 12 month annual growing period of the eucalypt site of Espirra in Southern Portugal (38º38' N, 8º36' W). This site, aimed for pulp production, is part of an intensive 300 ha eucalypt coppice, with about 1100 trees ha^{-1}. The climate is of Mediterranean type. During the measurement period mentioned (2002–2010), two main events changed the annual sink pattern of the forest: a drought period of two years (2004–2005) and a tree felling (November and December 2006). Before the felling, annual net ecosystem exchange (NEE) diminished from 865.56 g cm^{-2} in 2002 to 356.64 g cm^{-2} in 2005 together with a deep decrease in rainfall from 748 mm in 2002 to 378.6 mm and 396.6 mm in 2004 and 2005, respectively. In this period, drought was the main meteorological driver of these temporal tendencies in carbon uptake. The eucalypt stand recovered its carbon sink ability in June 2007 with a total NEE of 151 g.cm^{-2} from January to September 2010. A quantitative approach using generalized estimating equations (GEEs) was made to relate monthly NEE, gross primary production (GPP) and soil moisture with the main meteorological variables. Seasonal patterns of carbon uptake were almost opposite in the periods before and after the felling with maxima respectively in April and August, and, due to the maintenance of a mature root system by the coppice stands, this seasonal change is gradually reversing to the pattern before 2006.

Multiple stress induced decline of Scots pine in dry inner-alpine valleys in Switzerland

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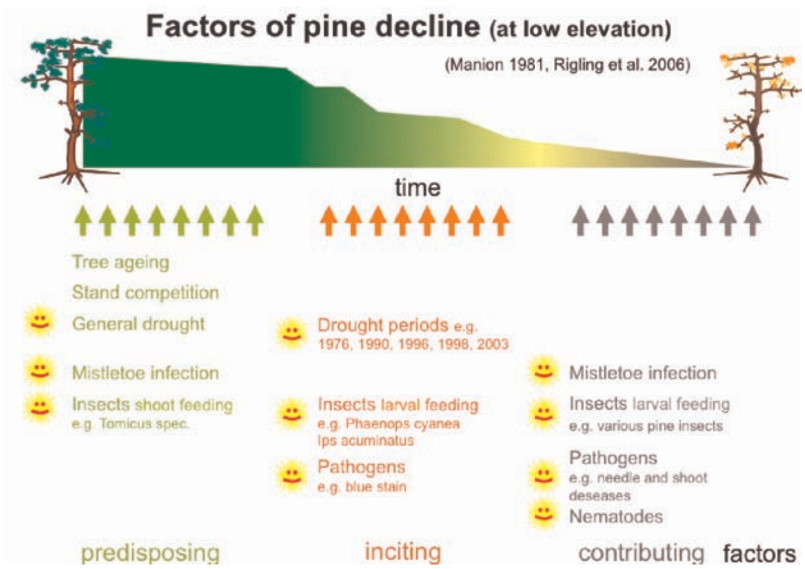
Scots pines growing in inner-alpine valleys (e.g. Rhone Valley, Switzerland) showed episodic decline during the last decades. Climate change, specifically drought stress has been postulated to be an inciting stress factor reducing tree growth. Thereafter, indirect effects related to warming such as increased bark beetle populations have become more frequent acting as contributing stress resulting in tree mortality. Simultaneously, a change in forest management occurred, namely, reduced thinning and abandonment of grazing, both increasing competition to trees. In this study, we examined if changes in forest practices act as predisposing stress fact*or for subsequent Scots pines decline.*

In a thinning experiment, set up in 1965, basal area was reduced by 20, 45 and 70% increasing tree growth by factors of 0, 2 and 4, respectively in the following 10 years. Mortality decreased with thinning intensity and heavy plots had a mortality rate comparable to non water-limited Scots-pine stands in Switzerland. The significantly drier period 1991-2009, showed increased mortality in all treatments, with a consequent decline in basal area in the control and light thinning plots.

A second experiment began in 2010 in an open canopy forest, where 12 mature pines trees were selected and the understory in a 5 meters radius was removed for 6 trees. The removal of the understory increased soil water content and consistently, increased tree water potential and transpiration. Control trees kept stomata close during drought periods while trees without understory kept almost 50% of the stomata open, thus, increasing tree growth two years after removal.

Reduced competition (predisposing factor) decreases drought intensity (inciting factor) and might indirectly reduce insect attacks (contributing factor). The observed pine decline is not only driven by climate change, but is largely a consequence of a change in forest practices, therefore, neither drought nor competition alone should be considered as decisive factors in the decline of Scots pine forest in dry environment.



Notes

Tusday, May 22
13:00 – 14:45

Session 6
Multiple Stressor Effects on Ecosystems

Chair persons:
Nancy Grulke and Mikhail Kozlov

(2nd part)

Using lichen functional groups as indicators of the effects of multiple stressors on ecosystems

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Climate change, atmospheric pollution and eutrophication are among the main stress factors associated to global change. In order to identify the critical areas affected by those factors and to verify the possible success of mitigation and restoration strategies we can use ecological indicators. Lichens are widespread on all land biomes, and are among the ecosystems components most sensitive to changes. Although lichens have successfully been used as indicators of the effects of atmospheric pollution in the past, we currently require a variable that responses to the factors associated to global change, to be able to separate the effects of co-occurring factors and do so in a spatial-explicit way.

The aim of this work is to use lichen as indicators of the effect of factors associated to global change in a context of multiple factors. In south-west Europe we characterized lichen functional *response* groups at two spatial scales (local, less 1km^2 and regional, more 1000 km^2) in semi-natural woodlands. We also measured atmospheric pollutants and also used land-cover as surrogate for multiple pollution sources, relating those environmental factors to lichen data.

We showed that lichen functional *response* groups (such as the eutrophication-tolerant *vs*. eutrophication-sensitive) must replace measures of total diversity. This happened because unlike previous pollution types (such as SO_2) that were lethal for nearly all lichen species, most factors associated to global change had different effects on each species, reducing some but promoting others. We used geostatistics techniques to determine variables spatial characteristics and adequacy of the sampling grid, and also to determine the scale at which indicators were related to environmental factors (e.g. climate at a larger scale, artificial-areas at shorter scales). Spatial analysis also allowed separating the effects of co-occurring environmental factors (e.g. pollution from agriculture or from bare-lands) and locating their specific areas of impact. This work highlighted the ways lichen can be used as indicators of factors associated to global change, even under the effect of multiple stressors.

Acknowledgements to FCT-MEC (PTDC/AAC-CLI/104913/2008, SFRH/BPD/75425/2010)

Nitrogen and water use paramets of young *Fagus sylvatica*

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Excess nitrogen deposition to forests has a variety of effects on forests. Usually an increased drought sensitivity is not among the effects reported. But this depends on the nutrition status of the trees. We are showing here results from a N addition experiment with *Fagus sylvatica* in the Swiss Jura, on a thin calcareous soil. N addition decreased the supply with both K and P from short to seriously deficient. During dry periods plants with N addition rates of ≥20 kg N ha^{-1} yr^{-1} (background deposition) showed signs of disturbed water balance. The most sensitive indicator was a decreased water use efficiency as assessed by isotopic ratio in the leaves ($\delta^{13}C$). Predawn water potential was significantly decreased at addition rates of ≥40 kg N ha^{-1} yr^{-1}. Another indicator was elevated night time transpiration which itself may be a sign of cavitation repairing processes. Foliar drought necroses were significantly increased at the highest N addition rate, 160 kg N ha^{-1} yr^{-1}.

K is known as an element playing an import role in stomatal regulation, and the foliar drought symptoms were more frequent when foliar K concentratios were deficient. However, the isotopic ratio was not correlated with the K concentrations but rather with the N:K ratio and, much more significant, with P concentrations. This suggests that the nutrition status of both P and K was involved in the increased drought sensitivity. This is of ecological relevance as the P concentration of the mature forest trees has decreased drastically during the last 25 years, and the N addition rates which caused an effect are well within the N deposition range encountered in Swiss forests.

Response of beech saplings to extreme and repeated summer droughts of relevance for stand establishment in the future

Michael Goisser[1], Ulrich Zang[2]
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Climate models for Central Europe predict increasing frequency and intensity of summer drought events. Since young beech saplings - as used for afforestation practices - are considered as particularly sensitive to severe drought, studies on sapling development under field conditions are important with respect to sustainable silviculture.

In a field experiment, the reaction of young beech (*Fagus sylvatica* L.) to extreme and repeated summer drought was examined. In 2008, three-year-old beech was planted under a Norway spruce stand opened through winter storm. Rainfall exclusion, irrigation and control plots without treatment (each treatment with three plots of $400 m^2$) allowed manipulation of precipitation in the growing seasons of 2009 through 2011, inducing a pronounced gradient of water availability. Volumetric soil water content in the rhizosphere was recorded continuously and via in situ calibration converted into soil matrix potential. Drought stress increased throughout the study period, reaching pF values of up to 4.7 in 2011. Cumulative matrix potential over time served as drought stress dose.

During each growing season diameter growth, photosynthesis, stomatal conductance and leaf water potential were recorded. At the end of each growing season, a subsample of plants was harvested to determine biomass, root morphology and total leaf area.

Significant correlations between drought stress dose and plant response were found. Diameter growth, photosynthesis capacity and stomatal conductance were reduced with increasing dose. Moreover, during the three years a decrease in drought sensitivity regarding diameter growth and photosynthesis was found. This is attributed to tree establishment at the site and acclimation as shown by increase in water-use efficiency, root/shoot ratio, rooting depth, specific fine root length and specific root tip density in relation to the drought dose. The results confirm sensitivity of young beech to drought but also reveal a great potential for acclimation due to physiological and morphological plasticity.

Intra-annual growth of adult beech (*Fagus sylvatica* L.) – influenced by short term water limitation and ozone uptake?

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The predicted scenario for forests in Central Europe is decreasing precipitation during growing seasons with more frequent short-term drought events in combination with rising ozone uptake. Impacts of global change effects on adult beech (*Fagus sylvatica* L.), especially the combination of limited water availability and ozone uptake, are rarely described realistically for stand conditions. In our study we focus especially on growth reactions at temporarily water-limited sites with future risk for intense drought, and on well-watered sites with predicted risk for rising ozone uptake.

To this end, ten well documented beech stands in Bavaria/Germany were selected and examined during the growing seasons of 2010 and 2011. Eight measuring sites were part of the Level II network (Bavarian forest ecosystem sites), and two were intensive research and monitoring sites (Kranzberg Forest, Forellenbach UN-ECE Monitoring). Xylem sap flow and stem increment at breast height were measured at high time resolution in addition to climatic, edaphic and phenological factors, as well as ozone concentration.

The evaluation of beech productivity is based on stress tolerance, assessed in relation to water consumption and ozone uptake. Xylem sap flow measurements in beech trees provide transpiration rates and, by up-scaling, stand-level water consumption. Stomatal ozone uptake is derived from canopy transpiration. Growth performance is examined as stress indicator.

Intra-annual variation in stem increment at high time resolution is analyzed for differentiating drought versus ozone impact across the different measuring sites. On such grounds, growth is hypothesized to reflect unifying response functions to drought and ozone doses, each at the regional scale.

Measurements of mass and energy exchange between pine afforestation and the atmosphere - past, present and future research at Tuczno site (Poland).

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Forest is one of the most important elements of the Earth biosphere. This type of ecosystem creates a favourable habitat for many species of plants and animals. In the context of global climate change, forest plays an important role as a sink of CO2. Negative changes in the global environment may affect for functioning of forest ecosystems. The direction and intensity of these processes will be possible to asses by the analysis of mass and energy fluxes which are exchange between the forest canopy and the atmosphere.

Water vapour (H2O) and carbon dioxide (CO2) fluxes were measured using eddy covariance (EC) method in order to obtain long-term data series. Measurements started in January 2008 and continue until today. EC tower was established at 24m tall Scot's Pine (Pinus sylvestris L.) stand, 56 years old afforestation, located nearby Tuczno town (North-West Poland). This forest represents a substantial portion of the all areas that are under the State Forests National Forest Holding management. It has been hypothesized that this type of forests, (age and structure) are responsible for the main net uptake of atmospheric CO2 at the territory of Poland. The first two years of measurements show that the total annual sequestrations amounts were surprisingly high (2008: 702 gC·m-2 and 2009: 747 gC·m-2). During the subsequent years absorbance has decreased (2010: 546gC·m-2 and 2011: 592 gC·m-2).

The main future objective of the research will help to find an answer for the following question: what factors, meteorological or air quality, determine the annual variance of the NEP?

The existing measurement tower has been recently equipped with devices to measure basic meteorological parameters and ozone concentration. Additionally, the research at Tuczno site will be also extended by hydrological measurements, nutrient cycle and soil properties surveys in order to comprehensive studies of forest ecosystem functioning. Fully equipped Tuczno tower is going to be a part of ICOS infrastructure in Poland.

Diurnal and seasonal variation in stem radius and water status of mature sessile oak *Quercus petraea* (Matt.) Liebl. and turkey oak *Quercus cerris* L. trees in relation to weather conditions

Ilona Mészáros[1*], Péter Kanalas[1], Balázs Nyitrai[1], József Kis[1], András Fenyvesi[2], Viktor Oláh[1], Zita Demeter[1], Erzsébet Szőllősi[1]

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[2] *Institute of Nuclear Research of Hungarian Academy of Sciences H-4026 Debrecen, Bem tér 18/c.*
**e-mail: immeszaros@unideb.hu*

Stem radial growth and water status of *Quercus petraea* and *Quercus cerris* trees were assessed with continuous dendrometer monitoring of stem radius and sap flow measurements at high temporal resolution time between 2008 and 2011 in a mixed forest stand (95-100 yr) at a xeric site in north-eastern Hungary. Growing season was the moistest in 2010 and was the driest in 2011. The total rainfall and mean air temperature values in growing season were as follows: in 2008 354 mm and 17,0^{o}C, in 2009 299 mm and 17,9 ^{o}C, in 2010 671 mm and 16,0 ^{o}C, in 2011 189 mm and 17,8 ^{o}C. Radial growth of trees was the most limited in 2009 due to the drought in spring. Dendrometer data were used for estimation of maximum daily stem shrinkage (MDS) reflecting loss of water from temporary stores in elastic tissues. MDS was low and varied less in moist growing season of 2010 (mean MDS 20 μm and 15 μm for sessile oak and turkey oak, respectively). During severe drought (e.g. August of 2011) MDS reached 80-90 μm in sessile oak and 60-70 μm in turkey oak. MDS changed in correlation with air vapour pressure deficit (VPD) during the growing season. The correlation was stronger in sessile oak and in dry growing season. The magnitude of tree (stem) water deficit variation (ΔW) (Zweifel et al. 2005) was generally smaller in *Q. cerris* than in *Q. petraea*. In contrast, *Quercus cerris* exhibited larger daytime sap flow density. At the low SWC during prolonged drought the transpiration was supported by the trees' inner water storage which resulted in high ΔW. Sustained ΔW also indicated insufficient soil water uptake to fully recharge the trees' stem tissues during drought. The study was performed with the support of OTKA No.68397 and TÁMOP-4.2.2/B-10/1-2010-0024, Life08 ENV/IT/000399.

Role of tree growth active periods in dendroecological research

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The target of this study is to work out methodology of determination of tree growth active periods and to substantiate the role of their use in dendroecological research. For reaching it there are too tasks to do - firstly, the explanation of conception of active periods and secondly, outlining in details the steps of the recognition of active period and giving of examples of the usage of them. The hypothesis of the research is based on fact that impact of several factors changes during the tree life; it can be different in intensity aspect (more or less intensive) and mode of action (positive or negative). It is advantageous to describe the idea of tree active growth periods connecting it with Shelford’s law of tolerance. If particular environmental factors (e.g. temperature, precipitation etc.) are in the zone of insufficiency or satiation growth and development of the biological object is limited.

There are tree ring width survey data and data of meteorological observations needed to design the special matrix. Next step includes calculation of Pearson’s correlation coefficient (r). Zones where phenomenon of interest is statistically significant (factor of study impacts tree growth substantially) are determined by critical values of correlation coefficient $r_{\alpha;n}$.

If it is possible it is recommended to strive to increase favourable impact during the positive active growth periods and to reduce it during the negative ones.

The temporal drift of active periods is interpreted as a criterion for global warming reflection.

Notes

Tuesday, May 22
15:15 – 17:00

Session 7
Environmental Quality and Pressures Assessment under Global Changes

Chair persons:
Lars Lundin and Alessandra Pugnetti

Organized by ENVeurope and ICP IM.

Sulphur and nitrogen input-output budgets at ICP Integrated Monitoring sites

J. Vuorenmaa[1], M. Forsius[1], L. Lundin[2], S. Kleemola[1], A. Augustaitis[3], B. Beudert[4], H.A. de Wit[5], C.D. Evans[6], J. Frey[7], I. Indriksone[8], D. S. Jeffries[9], P. Krám[10], M. Váňa[11]

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[7]*Tartu University, Institute of Ecology and Earth Sciences, Vanemuise St. 46, EE-51014 Tartu, Estonia*
[8]*State Ltd Latvian Environment, Geology and Meteorology Centre, 165 Maskavas Str., LV-1019 Riga, Latvia*
[9]*Czech Geological Survey, Department of Geochemistry, Klarov 3, CZ-118 21 Prague 1, Czech Republic*
[10]*National Water Research Institute, Environment Canada, P.O. Box 5050, Burlington, Ontario L7R 4A6, Canada*
[11]*Czech Hydrometeorological Institute, Observatory Košetice, CZ-394 22 Košetice, Czech Republic*

Annual sulphur and nitrogen input-output budgets were calculated for 19 forested sites in Europe and North America for the period 1990−2010 using open field (bulk) and throughfall deposition and runoff water data. Mass balance budgets integrate information about the complex chemical and biological processes that govern the retention or release of S and N compounds and regulate acid production and buffering in both the terrestrial and aquatic portions of catchments in the ecosystem.

Long-term assessment of mass balances in hydrologically and geologically well-defined catchments gives important information for the identification of ecological effects of different anthropogenically derived pollutants, and for documenting the effects of emission reduction measures. The sites − with the different soil and forest type characteristics − belong to the multidisciplinary UNECE ICP integrated monitoring network, set up to assess the environmental impacts of transboundary air pollution. A forest canopy filtering factor for each catchment was estimated for SO_4^{2-} by taking into account the specific filtering abilities of different stands based on the throughfall quality and the distribution of forest types. Because of the strong impact of canopy processes, bulk deposition measurements were used for NH_4^+ and NO_3^- as total deposition estimates in this study. Output fluxes from the catchments were calculated as the product of measured catchment discharge and ion concentrations.

The development of “supersite” plot and forest dynamic observations system in Polana mountains.

Rastislav Jakuš
Institute of Forest Ecology SAS, e-mail: rasti.jakus@gmail.com

In relations to anticipated ouputs of COST Action FP 0903 “Climate Change and Forest Mitigation and Adaptation in a Polluted Environment“ we are preparing forest ecosystem dynamic observation system in Poľana mountains in Central Slovakia. The system should contain a monitoring site in the category „supersite“ and mobile remote sensing system. Monitoring site will be focused on air pollution measurements, carbon, nitrogen and water cycles. Mobile remote sensing system will be based on automatic UAV (unmanned aerial vehicle) with laser and hyperspectral scanners. The aim of the whole system is to study spruce primeval nature ecosystem in conditions of global change.

Long-term vegetation responses at ICP IM sites in relation to deposition impacts

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Airborne nitrogen deposition is affecting forest ecosystems in many parts of Europe. One of a number of impacts is loss of biodiversity. Critical Load Exceedance (CLE) has been suggested as a prominent indicator to describe the risk of N deposition causing negative impacts on biodiversity. However, an assessment of its reliability is so far missing. This study is using long-term data from the ICP Integrated Monitoring network (CLRTAP) to 1) review published results for trunk epiphytes, aerial green algae, understory vegetation and trees, and to 2) compare trends of forest floor vegetation with CLE of sites across Europe. The review underpins existing knowledge about distribution of effects and differences in sensibility of biological receptors. The second approach shows that by using long-term monitoring data, CLE and trends of forest floor vegetation are only weakly related. We hypothesize that confounding factors such as forest management, reduced acid deposition, changes before the monitoring began, and response lags explains the lack of strong relationships. Several improvements for the calculation of CLE and for the monitoring of biodiversity are suggested.

Title: Empirical impact indicators agree with exceedances of critical loads

Maria Holmberg,
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Empirical impact indicators of acidification and eutrophication were determined from stream water chemistry and runoff observations at catchments in the Integrated Monitoring programme (UNECE ICP IM). The indicators were compared with exceedances of critical loads of acidification and eutrophication obtained with deposition estimates for the year 2000. Critical loads for acidification were calculated for the stream water with the Steady-State Water Chemistry model feeding into the First-order Acidity Balance model. Critical loads for eutrophication were established both with a simple mass balance model for the catchments with runoff observations, and as vegetation-specific empirical values for those sites with only vegetation plots without runoff observations. Annual mean fluxes and concentrations of acid neutralizing capacity (ANC) were negatively correlated with the exceedance of critical loads of acidification. Observed leaching of nitrogen was positively correlated with the exceedances of critical loads. With deposition estimates for 2020, although only one more catchment (7 cf. 6 of 18) would be protected from acidification, the average exceedance would decrease from 1 000 eq ha^{-1} yr^{-1} in 2000 to 300 eq ha^{-1} yr^{-1} in 2020. For the vegetation plots, the protection from eutrophication would rise from 15 (of 83) protected in 2000 to 57 protected in 2020. The presentation is a summary of work reported in a manuscript submitted to Ecological Indicators (Holmberg et al.).

Holmberg, M., Vuorenmaa, J., Posch, M., Forsius, M., Lundin, L., Kleemola, S., Augustaitis, A., Beudert, B., de Wit, H.A., Dirnböck, T., Evans, C.D., Frey, J., Grandin, U., Indriksone, I., Krám, P., Pompei, E., Schulte-Bisping, H., Srybny, A., Váňa, M. Relationship between critical load exceedances and empirical impact indicators at Integrated Monitoring sites across Europe. Manuscript submitted to Ecological Indicators.

Recovery of soil water, groundwater and streamwater from acidification at the Swedish Integrated Monitoring catchments

Stefan Löfgren[1], Mats Aastrup[2], Lage Bringmark[1], Hans Hultberg[3], Lotta Lewin-Pihlblad[2], Lars Lundin[1], Gunilla Pihl Karlsson[3] and Bo Thunholm[2].

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Recovery from anthropogenic acidification in streams and lakes is well documented across the northern hemisphere. In this study, we use 1996-2009 data from the four Swedish Integrated Monitoring catchments to evaluate how the declining sulfur deposition has affected sulfate, pH, acid neutralizing capacity, ionic strength, aluminum and dissolved organic carbon in soil water, groundwater and runoff. Differences in recovery rates between catchments, between recharge and discharge areas and between soil water and groundwater are assessed. At the IM sites, atmospheric deposition is the main human impact. The chemical trends were weakly correlated to the sulfur deposition decline. Other factors, such as marine influence and catchment features, seem to be as important. Except for pH and DOC, soil water and groundwater showed similar trends. Discharge areas acted as buffers, dampening the trends in streamwater. Further monitoring and modeling of these hydraulically active sites should be encouraged.

For further information on this work see article in AMBIO, Vol 40, No 8, pp. 836-856, 2011
http://www.springerlink.com/content/0044-7447/40/8/

Testing common monitoring and research parameters: the EnvEurope field exercise

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The LIFE+ project EnvEurope (www.enveurope.eu) proposes a design for environmental high quality monitoring sites and the exemplary establishment of common parameter sets to be collected across the largest site-based network of Long-Term Ecosystem Research in Europe (LTER Europe: www.lter-europe.net). The central idea is to test the network as as an integrated and shared system for ecosystem monitoring.

Within EnvEurope, Action 5 represents the experimental phase, based on the sampling of new and pre-existing parameters and indicators at different level/scales of investigation. According to the variability of the European ecosystems and LTER sites, a set of the recommended parameters are cross-cutting among sites (e.g. meteorology, substrate chemistry, primary productivity, biodiversity), while another part of them is habitat specific.

The overall objective is to assess the state and trend of European ecosystems for a set of commonly established parameters that will be collected at approximately 70 sites in different ecosystem types. Agreed and harmonised methodologies will be applied with specific monitoring intensities and a multi-level/multi-functional approach. Both "traditional" and newly decided parameters (within action A2) will be collected and methods will be tested and applied.

This will be realised by a field exercise, the "testing in the field" campaign. A preliminary test has been implemented in 2011 on a sub-set of the EnvEurope sites but the central year for the campaign is 2012, when all the sites will be participating,.

By developing a database of commonly established parameters, the Action will support the assessment of the states and trends of the European ecosystems in LTER sites, pointing to the evaluation of environmental quality across Europe. Contribution to GMES-Kopernicus and to the SEIS initiative for data sharing and publicity is considered.

The presentation will describe the field exercise, its scale and status, with examples from selected sites.

Mercury in stream and wetland porewater in two Norwegian catchments

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Mercury (Hg) concentrations in predator fish in Norway exceed limits advised for human consumption. The main source of Hg in fish is atmospheric long-range transported pollution, which accumulates in northern catchments and is released from soils into surface waters, from it enters the food chain. Under anaerobic conditions such as exist in wetlands, ionic Hg can be transformed into the neurotoxin methylmercury (MeHg) by sulphate-reducing bacteria. MeHg bioaccumulates effectively and is dominant form of Hg in fish.

MeHg levels in invertebrates in two streams in Norway were found to be associated with aqueous MeHg levels in these streams, suggesting that exposure to aqueous MeHg is an important driver of MeHg in the food chain. Streamwater variations of MeHg, however, are poorly understood. Wetlands are thought to be the main source of streamwater MeHg.

The two streams exhibit puzzling differences in seasonal patterns of MeHg despite large similarities in catchment properties. We hypothesized that differences in streamwater MeHg were related to wetland soil and porewater characteristics, alternatively to differences dissolved organic matter (DOM) characteristics and sulphate cycling. Relations between total Hg and DOM quality were also investigated.

We found to our surprise that the wetland in the catchment with highest streamwater MeHg acted as a *sink* for MeHg. Wetland porewater MeHg did not have explanatory power for streamwater MeHg, a possible indication that uplands also contribute to the streamwater MeHg signal. There were catchment differences in sulphate: more porewater sulphate but lower streamwater sulphate in the catchment with highest streamwater MeHg. Possibly, SO_4 is reduced more effectively in the catchment with highest streamwater MeHg, thereby producing more MeHg.

Total Hg in streamwater was strongly correlated to TOC and UVabsorbance, while those correlations were much weaker for MeHg. Biodegradable DOC in both streams was similar. Tangential ultrafiltration of porewater and streamwater will be conducted to evaluate DOC quality differences and assocations of DOC fractions with Hg.

We conclude that wetlands can be sinks for MeHg. Total Hg is strongly associated with TOC, while MeHg dynamics are controlled by multiple factors – chemical, microbiological and hydrological. The wetlands in the investigated catchments do not necessarily promote MeHg-leaching. The role of uplands for MeHg in surface waters needs more attention.

Indicator assignment and selection for Long-Term Ecosystem Research (LTER) and Monitoring sites

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One of the basic prerequisites for the global (ILTER), the regional (e.g. LTER-Europe) and national LTER networks is an agreed set of parameters to be measured at LTER sites which are already operating or being conceptualized for a long time (>10 years). A common approach linking parameters to indicators and overarching concepts is still missing, although there are a lot of indicator initiatives like e.g. SEBI 2010, GEO BON, the EEA core set of environmental indicators etc. which have often been developed for specific (political) intentions. In order to improve the power of the LTER network there is an urgent need to agree on common parameter sets leading to common data sets. The work towards the improvement of LTER-Europe is mainly supported by the Life+ project ENVEurope (www.enveurope.eu).

We compare the (1) DPSIR model (Driver-Pressure-State-Impact-Response), the (2) concept of Ecological Integrity and that of (3) Ecosystem Goods and Services and evaluate their suitability for LTER sites. Most of the actually measured LTER parameters reflect pressures and states of ecosystems. The state itself is the base for ecosystem goods and services. The ecological integrity concept was adapted within ENVEurope to fit to long term research and monitoring of ecosystems. Ecological integrity is defined as a target for the preservation against non-specific ecological risks, which are general disturbances of the self-organizing capacity of ecological systems based on ecological processes and structures. We demonstrate the application of this concept for linking indicators to parameters and methods and the way to come to agreed and feasible sets of parameters.

Notes

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Wednesday, May 23
13:00 – 14:45

Session 8
Genetic Aspects

Chair persons:
Gerhard Müller-Starck and Om P. Rajora

Genic responses of black spruce to climate change

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Rapid climate change (elevated CO_2 levels and rising atmospheric temperatures) is subjecting our forests, especially Boreal and temperate forests, to significant abiotic stresses, such as drought, which can affect health, productivity and fitness of our forests. Therefore, it is essential to understand genic responses of forest trees to climate change conditions. We have investigated this topical aspect in black spruce (*Picea mariana*) - a transcontinental, ecologically and economically important tree species of the North American Boreal forest. Our objective was to identify and characterize genes expressed differentially in response to elevated CO_2, drought and co-stressed conditions in black spruce.

We have used 454 and Illumina NGS platforms for whole transcriptome sequencing, cDNA-AFLP, qPCR and bioinformatics analyses to identify, annotate and characterize genes expressed differentially in response to elevated CO_2, drought and combined elevated CO_2 and drought conditions in black spruce using the cloned material. Thousands of transcripts (genes) showed differential expression (no expression, up-regulation or down-regulation) in response to elevated CO_2, drought and/or their combined conditions, with over 1600 genes from several pathways showing >10-folds gene expression differences between the control and treated plants. Responses to each treatment at the gene expression levels were correlated well among different genotypes. We will present these results, which contribute significantly to our understanding of trees’ genetic responses to global climate change.

Comparative genomics of ozone stress response in hardwood tree species

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The main goal of our project entitled "Comparative genomics of environmental stress responses in North American hardwoods" is to create genomic resources for an array of economically and phylogenetically important hardwood species in North America. This will provide lasting genomic and biological resources for the discovery and conservation of genes in hardwood trees for growth, adaptation and responses to environmental stresses such as ozone, drought, heat, insect pests and disease. These resources are being made available to the scientific community and the public through the project website (www.hardwoodgenomics.org). At this time we report recent results related to gene network analysis of Black cherry (*Prunus serotina* Ehrh.) seedlings, Northern red oak (*Quercus rubra L.*) seedlings, and three Poplar hybrids exposed to ozone stress under controlled conditions. Our results show that in Red oak and Black cherry ozone stress has resulted in down-regulation of the expression of a number of genes in the chloroplast and up-regulation of a number of genes in the mitochondria. We observed increased activity in genes known to be associated to oxidative stress (Catalases, Peroxidases, etc.), and decreased activity in genes involved in the Photosynthesis and ATP-synthesis. In a different study we observed that ozone stress compromised the response of poplar hybrids (OGY, NE-245, NE-388) to biotic stress (i.e. changed activity in an array of genes that were activated only under biotic stress and were not activated when ozone stress preceded the biotic stress). The Black cherry project was supported by a grant from the USDA NIFA Plant Genome Program (#2008-35300-19234). The Comparative Genomics of Environmental Stress Responses in North American Hardwoods project is supported by the NSF PGRP Award #1025974.

Ozone-induced detoxification processes in three populus genotypes: Metabolomic and molecular approaches

Dumont J[1,2,3], Keski-Saari S[4], Keinanen M[4], Kontunen-Soppela S[4], Cohen D[1,2,3], Ningre N[1,2,3], Ata Allah Dghim[1,2,3], Vaultier M.N[1,2,3],Baldet P[5], Gibon Y[5], Dizengremel P[1,2,3], Jolivet Y[1,2,3], Oksanen E[4], Le Thiec D[1,2,3].

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Tropospheric ozone acts as a phytotoxin which produces an oxidative stress in plants. Two ways of defense are used, either by preventing ozone input through the regulation of stomatal conductance, or by detoxifying ozone and ROS within cells. It is well known that the *Halliwell-Asada* pathway is one of the main systems of detoxification and that ascorbate and glutathione are two key players in this process. We performed fumigation experiment on three euramerican poplar genotypes (*'Carpaccio'*, *'Cima' and 'Robusta'*), cultivated in pots in phytotronic chambers submitted to 120 ppb ozone or filtered air. Leaf samples were collected 2, 4, 11, 15 and 17 days after the start of ozone treatment. The genotypes differed in growth rate and in ozone sensitivity. We followed the impact of ozone on root, stem and leaf biomass. We explored the effects of ozone on ascorbate and glutathione concentration, and to better understand how their concentration increased, we studied by qPCR the expression of genes implicated in their biosynthesis. These results are coupled with metabolomic analyses made by HPLC-APCI-MS. We found out that ozone induced, in all genotypes, a decrease of carotenoids, chlorophylls a and b, and polyisoprenoids alcohols, and those differences were the strongest on the last two sampling dates. The treatment effect explained more than 50% of the variance between samples. Even though the genotypes differed from each other, it seems that ozone sensitivity in poplar was not driven by carotenoids contents but more by ascorbate and glutathione contents. The originality of this study lies upon the combination of different approaches, the comparison of the three genotypes and the presentation of results in relation to Phytotoxic Ozone Dose.

Acknowledgements. J. Dumont thanks the COST action FP0903 (STSM) and the ANR VULNOZ for providing financial support to do part of this work

Tree Genetics and Reconstruction of Secondary Coniferous Forests: A case Study from the Western Beskids Mts., Slovakia

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Western Beskids Mts., a northwestern brim of the Carpathians, is known for the decline of secondary spruce-dominated forests since the late 1990´s. Air pollution from the neighboring industrial Silesia has contributed without a doubt to this process. Series of soil analyzes demonstrate long-term effects of pollution. Local climate is relatively humid but several dry years occurred during the last decade. Also prediction models suggest future climate increasingly limiting Norway spruce. Reconstruction of local forests therefore relies on the change of tree species composition, with much more beech and silver fir. However, forest owners still prefer Norway spruce. Moreover, common beech and silver fir became rare in the area, and much of their reproductive material must be delivered from other regions. In such situation, genetic quality of forest reproductive material is of the utmost importance. Our study of genetic aspects of fitness and adaptability is based on the assessment of common garden experiments:

- In Norway spruce, we evaluated a series of five provenance plots (age 45) at different elevations covering its whole cultivation range. Our analysis focused on the effects of transfer of provenances on growth, survival, phenology and selected physiological traits using the concept of ecodistances between parent stands and planting sites.

- In common beech, two provenance trials were evaluated (age 10) with focus on juvenile growth, survival and vegetative phenology including frost avoidance.

With regard to growth and survival of the studied species, genetic factors proved to be equally as important as the site quality and climate. In phenology and frost avoidance, however, we observed only limited local adaptation. On this basis, and with the knowledge of possible genetic background of susceptibility of tree species to their fungal pathogens, we tackle the question of selecting suitable forest reproductive materials for different future environments.

Genetic differences in lammas growth of Scots pine in response to prolonged vegetation period

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Evolution favors trees that use all available resources in local conditions. Rapid changes of climatic conditions involve also modification of resources availability, including increase of length of vegetation period and it will take number of generations for trees to adapt. As immediate response to longer vegetation period higher frequency of trees with lammas growth – second height increment at the end of vegetation period – is observed. Lammas growth can lead to higher number of branches, occurrence of spike knots and frost damages. Objective of the study is to evaluate possibilities for reduction of occurrence of lamms growth in tree breeding process. Occurrence of lammas growth was assessed in two open-pollinated progeny trials, including 60 Scots pine plus tree families and located in central part of Latvia. Both trials were established in *Vacciniosa* forest type, initial spacing 1.5x2m, and not less than 20 trees per family assessed at the end of 5th and 6th growth season. Results reveal significant differences in occurrence of lammas growth between years and test sites. On-site measurements of meteorological conditions demonstrate notable influence of temperature at the end of vegetation period on this trait. Significant differences between Scots pine families were found in proportion of trees with lamas growth. Besides, most affected families were the same in both years of assessment. That indicates possibilities for improvement via tree breeding process. There was also no genetic correlation between frequency of trees with lammas growth and height increment, indicating no negative effect of such selection on productivity.

Boon and bane of endophytes in a changing environment

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Endophytes are defined to be microorganisms living inside plant tissues or inside cells. Numerous examples show that these colonists are symptomless or even live in a symbiotic relationship with the host plant. The latter produce substances either enhancing plant growth or increasing stress tolerance of the host. Others protect the plant against e.g. insect attacks. Since a few years a number of studies is focused on endophytic microorganisms in forest trees which produce specific biologically active molecules, applicable as repellent systems against insects or nematodes. On the other hand, recent findings in forest trees show that some endophytic fungi may cause severe damages to the plant under certain conditions.

The presentation will address the role of endophytes in forest trees under changing environmental conditions with special respect to questions of adaptedness and adaptability. As an example, we will use the interaction between Douglas-fir and Rhabdocline needlecast

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Wednesday, May 23
15:15 – 17:00

Session 9
Hydroecology

Chair persons:
Yusuf Serengil and Stanislaw Malek

The impact of deforestation caused by ecological disasters on the spring water chemistry in the Beskid Śląski Mts.

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Chemical characteristics of mountain spring waters are very interesting due to its complexity. This paper presents an attempt to determine interactions between water circulation and biotic processes. The study concerns springs located on the slopes of Skrzyczne in the Silesian Beskid Mountains. Samples were collected in 2009 and 2011 during 3 different weather conditions. It is expected to find the significant differences in water chemistry between these 3 periods and between springs which are under influence of different plant cover. The differences should exist due to structure of geological bedrock (godula sandstone) which cause shallow water cycle (Krause et. al. 2010) and moreover they are suggested in previous article concerning research on the same terrain conducted in 2004 (Astel et. al. 2008). Grouping analysis of samples from the year 2009 and 2011 resulted in following findings: a) air pollution with nitrates influences spring water chemistry in Silesian Beskid Mountains with the strongest impact during snowmelt; b) intensive rainfall indicates increased leaching of nutrient cations and additionally SO_4^{2-} and Cl^-; c) the influence of plant cover is confirmed especially during snowmelt and precipitation period; d) beech and mixed stands increase: conductivity, Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+ and Cl^-, SO_4^{2-} concentrations, whereas bare areas, dieback areas and coniferous forest crops decrease reaction, conductivity, Na^+, K^+, Ca^{2+}, Mg^{2+} and NO_3^-, Cl^-, SO_4^{2-} concentrations and spruce stands decrease reaction, conductivity and Ca2+ concentration.

Acknowledgements: this work was created thanks to the grant No. 2011/01/B/NZ9/04615: The impact of deforestation caused by ecological disasters on the spatial heterogeneity and changes in springwater and surface water chemistry in the Beskid Śląski Mts.

Stream water chemistry and internal nutrient fluxes in a Malaysian tropical rainforest

Naoyuki Yamashita[1], Hiroyuki Sase[1], Ryo Kobayashi[1], Shigeki Uchiyama[1], Siniarovina Urban[2], Toh Ying Ying[2] and Nick Chappell[3]

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The Acid Deposition Monitoring Network in East Asia (EANET) has promoted case studies on catchment-scale analysis in several forest types of the East Asian region. Especially, nutrient imbalances by fluctuation of atmospheric depositions are inadequately understood in tropical rainforest. Dissolved matters in rainfall, throughfall, soil solution, and stream water had been observed for 3 years by biweekly sampling or ion exchange resin method in forested catchment at Danum valley, Sabah in Malaysia. In the stream, seasonal pattern of water chemistry was generally unclear. Particularly, pH was relatively high (ca. 7.0) and stable in the stream through a year. Meanwhile, NO_3^- and DOC modestly increased with high water flow rate in heavy rain event. Significant correlation between SiO_2 and cations suggested that cation-leaching from the catchment was derived from weathering process. In soil layer, pH of soil solution was lower in 20 cm depth (ca. 4.8) than in 70 cm depth (ca. 6.0). High concentration of NO_3^- and DOC (including organic acid) in surface soil may lead to a decrease in pH. Principal component analysis for soil solution and stream water revealed that pH was mainly controlled by NO_3^- and DOC in the soil layer and by cations in the stream. In vertical distribution, annual fluxes of almost all ions rapidly increased from canopy to soil layer and decreased in the stream. The rate of the decrease from soil to stream were more pronounced in NO_3^-, NH_4^+ and K^+ than in Na^+, Ca^{2+} and Mg^{2+}. In addition, leaching of Na^+, Ca^{2+} and Mg^{2+} via stream greatly exceeded input via atmospheric deposition. Therefore, in the tropical rainforest, high weathering capacity in deeper soil (or pervious rock layer) may contribute to low sensitivity of stream water chemistry to atmospheric deposition or heavy rain event accompanied with the leaching of NO_3^-.

Atmospheric deposition and stream water chemistry in a Japanese cedar forest – 10-year surveys along Sea of Japan

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The Acid Deposition Monitoring Network in East Asia (EANET) has promoted case studies on catchment-scale analysis in several forest types of the East Asian region. A small catchment plot was established in a Japanese cedar (*Cryptomeria japonica*) forest at Kajikawa site, Niigata Prefecture in central Japan. The area along the Sea of Japan has a strong effect of seasonal winds in winter. Throughfall (TF), stemflow (SF) and stream water (SW) have been collected biweekly/monthly in the catchment plot since 2003. Sampling of SW during heavy rain events were conducted intensively. Deposition amounts of all ions by TF+SF significantly increased from autumn to winter due to effects of the seasonal winds. The deposition amounts by TF+SF were the highest level in Japan, 30 kg S ha^{-1} y^{-1} and 17 kg N ha^{-1} y^{-1}. The largest N deposition by RF, 28 kg N ha^{-1} y^{-1}, was recorded in water-year 2007-2008. The total N deposition may be much higher taking canopy interaction into account. The NO_3^- concentration in SW still showed the seasonality suggesting regulation by plant uptake. However, the concentration was relatively high even in base-flow periods and temporary acidification with NO_3^- leaching was also observed in heavy rain events. Moreover, the NO_3^- concentration in SW slightly increased in recent years and the pH became lower than before. The Japanese cedar trees at Kajikawa site became approximately 40 years old, which could be harvested soon. Forest maturing as well as the large N deposition may affect N cycle in the catchment.

Displacements of Carbonate Equilibria in Polish Tatra Mountain Waters in the Last Fifty Years

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Polish Tatra Mountains are a unique area of research in terms of hydrochemistry, as a thorough research of chemical composition of water from over 800 springs, lakes and watercourses was conducted there in 1950–1960 using classical methods of analysis. Over the period of 2007–2009, waters of 1505 locations were re-examined, including 687 previously studied sites. What is most important, concentrations of HCO_3^- and Ca^{2+} have increased by 30% in last 50 years. The increase of HCO_3^- and Ca^{2+} concentrations cannot be explained only by the increase in atmospheric CO_2 concentration by ~70 ppm. Only a slight increase in spring water of the ridge parts of the High Tatras, without soil cover, may be directly linked with increased mineral leaching rate caused by an increase of CO_2 partial pressure. However, this kinetic model does not explain the much larger increase in HCO_3^- and Ca^{2+} concentrations observed in waters with higher mineral content, such as spring waters located in the lower parts of granitoid Tatra Mountains and in the sedimentary section. On the other hand, the assumption that in this case we are dealing with an open system with a continuous supply of CO_2 from air into water, but still maintaining the following equilibria: CO_{2air}–CO_{2aq}–H_2CO_3–HCO_3^-–CO_3^{2-}, leads to the conclusion that the observed changes in concentration of $HCO3^-$ would require that CO_2 concentration in the air was up to 2–3 orders higher than the actual one. The subject of the presentation will be the identification of the causes of the observed carbonate equilibria displacements with respect to changes in the cover and use of forests and changes in air and precipitation pollution.

Monitoring of soil moisture dynamics in fluvisol under changig climate

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Total forest area in Serbia is 2,252,400 ha (29,1 %). Total agriculture area in Serbia is 3,594,800 ha (46,4 %). In lowland forests most common species are *Quercus robur* and *Populus sp.* Monitoring included the functioning of ecosystems (soil, plant and insects).

Observed impacts of climate change is most obvious in increasing of temperature and decreasing of annual precipitation. This two factors leads to drought which is quite often natural hazard in Serbia with serious damages to national economy, especially to agriculture, forestry and water resources. Dry years were particularly frequent in the last two decades of the 20th century.

Research conducted in the protected part of the alluvial plains of the Middle Danube Basin on fluvisol. The higher average air temperature is determined for the entire period of study. The greatest departure from normal for the air temperature in the vegetation period is established in June 2003 (4.6ºC higher temperatures compared to normal). In relation to the normal air temperature is less established in June, October, November 2001.

During the period a pronounced deficit water in soil was in the investigated period. The differences occur for the vegetational period 2001th year where the climate was favorable, and where the changes were at least water, which can be correlated to the amount of rainfall was above average for the normal established for research. The observed decrease in precipitation and low contents moisture in soil is causing serious afforestation problems.

Acknowledgement:
This study is results of project III 43002 financed by Ministry of Science and Technological Development of Republic Serbia.

Changes in chemical composition of spring waters in the Świętokrzyski National Park under the influence of permanent high acid deposition

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Springs being the natural groundwater outflows respond well to any changes that occur in natural ecosystems [Wolanin and Żelazny 2010] and therefore can be classified as important hydrogeological indicators. The study was carried out in the year of 2010 in the Łysogóry Mts. in Świętokrzyski National Park. Łysogóry Mts. are built mainly of extremely acidic cambrian quartzites and quartzite sandstones [Kowalkowski et al. 2001]. Research area is located under the permanent influence of high acidic deposition, even from long-range emitters (> 100 km) like Upper Silesian Industrial Region, Agglomeration of Kraków and Bełchatów Brown Coal Mine [Joźwiak and Kowalkowski 2003]. Water samples were collected from springs in three sessions: during snowmelt (March/April 2010), the second during intensive rainfall and the beginning of vegetation season (May 2010) and the third session during low water level (August 2010) to verify the hypothesis that chemical composition of spring waters depends on permanent high acidic deposition. A data set consisting of conductivity, water pH, concentrations of major anions (Cl^-, NO_3^-, SO_4^{2-}) and cations (NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}). Analyzed springs are characterized by a shallow supply [Michalik 2008], so a big impact on their chemical composition, have a precipitation (rain and snow). Studies have confirmed the correctness of the hypothesis and strong dependence of water chemistry from wet acid deposition. Additionally there were significant differences in the content of NH_4^+, Na^+, Cl^-, SO_4^{2-}, and pH values between sessions in the low water level and the first and second sessions, which were confirmed by statistical analysis.

Is there a perspective for oaks in Slovenian lowlands?

Matjaž Čater
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In Slovenia, forest ecosystems with oaks are experiencing clear impacts, particularly on sites which are under severe agricultural pressure. The proportion of adult forest stands is declining and sanitary cut increases due to physiological weakening and high mortality. Consequences are uneven stand structure associated with regeneration problems. Recent studies suggest that reduction of natural area in lowland forests is in direct connection with agricultural activities and reduction of groundwater table.

On permanent research plots, established to address the problem systematically crown conditions and mortality have been observed from 1995 on. For largest forest complexes critical levels for the survival of oak seedlings under different light conditions have been defined; young oaks growth response (radial and height increment) was compared in different dry and favourable years as well as their response to increase of forest gaps. Adult oak response (osmoregulaton) in relation to different groundwater table was studied between stands with different tree density and results have been compared with dendrochronological analysis of adult trees in managed and old growth forest. Some silvicultural approaches are discussed to adjust recent management praxis to recent structural and stand conditions in changing environment.

Notes

Thursday, May 24
8:00 – 9:45

Parallel Session 10
Mechanisms of Action and Indicator Development

Chair persons:
Rainer Matyssek and Alessandra Kozovits

Mechanisms of Action in and Indicator Development for Forests under Climate Change and Air Pollution – from Gaps in Evidence to Integrated Knowledge

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This contribution is considered as an opening statement to Session 10 “*Mechanisms of Action and Indicator Development*”, referring to a position paper recently released by the COST Action MAFor (Matyssek et al. 2012, *Forests under Climate Change and Air Pollution: Gaps in Understanding and Future Directions for Research*. Environmental Pollution 160: 57-65) that can give stimulus and orientation to this part of the conference. Subjects negotiated here aim at mechanistic understanding and distinct identification of tree and forest level response specific to climate change and air pollution impact, and in such terms, comply with the conclusion of the position paper, which postulates and exemplifies ways to integrated process-based empirical and modelling research. This integration is to be borne by a new concept of “Supersites” for multi-scale ecosystem research. Four foci were identified of relevance for research covered in Session 10, namely, (i) mechanisms of atmosphere-ecosystem interaction, (ii) significance of biotic processes in determining and modifying system response, (iii) tool development for mechanistic and diagnostic understanding towards tree-ecosystem scaling and consolidated risk assessment, and (iv), unification of modelling and empirical research towards comprehensive evidentiary synthesis. Such foci have to be viewed within the global dimension of air pollution as part of climate change and regarding the needs for knowledge transfer to policy development and provision of scientifically reliable grounds for socio-economic decision making. It is to be explored how such demands may be translated into “Supersite” research, and how the expertise of Session 10 may “catalyze” respective efforts.

Differences in ozone sensitivity within and among two varieties of cutleaf coneflower (*Rudbeckia laciniata* var. *digitata* and *R. laciniata* var. *ampla*)

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Individuals of cutleaf coneflower (*Rudbeckia laciniata* var. *digitata* and var. *ampla*) exhibit substantial variation in their sensitivity to ozone, as expressed by the severity of foliar stipple. Variety *digitata* is native to Great Smoky Mountains National Park (GRSM), whereas var. *ampla* is restricted primarily to the Rocky Mountains (RMNP). The two studies described herein were initiated to investigate within and among varietal differences in ozone sensitivity. Sensitive individuals of var. *digitata* have been shown to develop foliar symptoms earlier and to a greater extent than adjacent insensitive neighbors. In August of 2004, leaves from sensitive and insensitive individuals of var. *digitata* were collected at Purchase Knob in GRSM and put through a dehydration/fixation series and examined under light microscopy. A variety of anatomical and morphological parameters were measured, including stomatal density, cuticle thickness, palisade and spongy mesophyll cell size and surface area, cell wall thickness, and the amount of airspace in the two cell layers in the leaves, none of which were correlated with differences in sensitivity for individuals of var. *digitata*. In 2010, rhizomes of var. *digitata* were collected from GRSM, and of var. *ampla* from RMNP and exposed to ambient ozone during the 2011 growing season in Boone, NC. The percent of plants, percent of leaves on a plant, and leaf area with ozone-induced foliar stipple were all substantially greater in var. *digitata* than var. *ampla*. We conclude that within var. *digitata* leaf anatomy and morphology do not contribute to the observed sensitivity differences among individual coneflowers. In addition, var. *digitata* appears to be more sensitive to ozone than variety *ampla*. The bases for these differences in sensitivity within and among varieties are, at this time, still unknown. Fumigation experiments are planned for this coming growing season to further compare ozone responses of var. *digitata* and var. *ampla*.

Ecochemical condition of soils after fertilization of dying old spruce (*Picea abies* (L.) H. Karst.) stands in the Beskid Śląski and Żywiecki Mts.

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The experimental plots were located in the middle forest zone (900-950 m) on two nappes of the flysch Carpathians: Magura (Ujsoły) – moderate forest decline - and Silesian (Wisła) – severe forest decline – in spruce stands of age 80-100 years. Dolomite, magnesite and serpentinite treatments were applied in the fall of 2008 on experimental plots. The chemical composition was determined from soil solutions collected (before fertilizing and after) in lysimeters placed at a depth of 20 cm in the fall of 2008 From samples collected in the spring and autumn 2009 - 2011, ecochemical parameters were calculated: acid neutralization capacity (ANC_{aq}), alkalinity (ALK), the degree of soil acidity (Ma%), acidic cations (Ma), saturation of the exchangeable complex of the solid soil phase (Mb) with alkalis, saturation with alkalis (BS), and molar ratios Ca/Al, Mb/Al, BC/Al.

After fertilization and winter, soil solutions became acidic, especially in Wisła. The saturation of the studied soils demonstrates moderate adaptability of soils in Wisła in relation to acid load, and high adaptability of the Ujsoły soils. The opposite trend was observed for the degree of acidity of soils. ANC_{aq} and ALK increased after application of fertilizers and showed significant variations in soil pH even in the case of small variations in the composition of the solution caused by the inflow of NO_3^- and SO_4^{2-} anions. After application of the fertilizers, an increase of Mg, Ca and Mb was noted in the soil solution, determined in the overlaying highly acidic organic horizons although the ion-exchange buffering affected positively soil water reaction especially on dolomite plots in Wisła. Aluminum stress in old spruce is unlikely, while trees in the control plots in Wisła may already be sensitive, but increasing release of Mg and Ca from fertilizers changed this relation positively as well.

A negative correlation was noted between the pH values, total alkali content, degree of saturation of the sorptive complex with alkalis in surface soil layers under analysis on the one hand and the ANC_{aq} and ALK of the analysed soil solutions on the other hand, which may be explained by an increased rate of organic matter mineralization and the activation of the nitrification process.

Acknowledgement. This work was financed by the State Forests National Forest Holding in Poland within the project: 3/08 - Forest management measures improving the growth, nutrition and health conditions in forest regeneration areas and endangered stands in the Beskidy Mts, with particular emphasis on soil revitalization with dolomites and new multi-component long-acting fertilizers.

Possible use of introduced species *Pinus contorta* for biomass production in Latvia

Linards Sisenis[1], Juris Rieksts-Riekstins[2], Raitis Rieksts-Riekstins[2], Janis Jansons[2], Aris Jansons[2]

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Carbon sequestration in forests and use of wood to replace fossil materials are important ways to mitigate climate change effects. Therefore different alternatives to increase forest productivity need to be investigated. One possibility to reach this goal is establishment of plantations of introduced species. Number of options (species and hybrids) for this purpose exists for fertile, former arable lands, but so far there are no alternatives for use in nutrient-poor, sandy soils. Objective of the study is to develop equations and estimate biomass of young lodgepole pines in Latvia. Material for the study was collected in 26 year old provenance trial in central part of Latvia, *Vacciniosa* forest type, established with initial spacing 1x2m, no thinning carried our prior to measurements. Altogether 237 vital trees without visible damages, representing all diameter classes and provenances, were sampled during January and February of 2010. Weight, moisture and density of stem, green and dead branches were measured for all trees, needle mass and moisture and bark mass and moisture was assessed for part of the material. Results reveal, that average diameter of tree has reached 10.5±1.29cm, height 9.8±0.70m. Main part (54% on average) of absolute dry above-ground biomass is stem – weight 22.2±1.39kg. Second most important fraction are green branches (19%) followed by needles (13%). Mass of bark and dead branches is only 6 and 8% of total above ground biomass of the tree. Breast height diameter is the best variable to use for estimation of above ground biomass: developed models ensured relative high precision for calculation of absolute dry weight of stem (R^2=0.95), green branches (R^2=0.78) and dead branches (R^2=0.58). Stand-level biomass production calculated with the equations, was notably higher for *Pinus contorta* than *Pinus sylvestris*, indicating the possibilities for practical use of this introduced species.

Changes in threshold for Ps and gs decoupling with increasing O_3 concentrations in cultivated and uncultivated species

Nancy Grulke[1], Elena Paoletti[2], David Grantz[3], Rainer Matyssek[4]
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[3]*Kearney Agriculture Center, UC Riverside, USA*
[4]*Technical University of Munich, Germany*

The majority of the research on plant response to ozone has shown a decrease in stomatal conductance (gs) as a secondary response to a primary effect of decreased photosynthesis (Ps) (Paoletti & Grulke 2005 Environmental Pollution 137:483). A series of experiments by our research group (Grulke et al., 2004 Tree Physiology 24:1001; Grulke et al., 2007; Grulke et al., 2007 Environmental Pollution 146:640; Paoletti & Grulke 2010 Environmental Pollution 158:2664) has suggested a direct effect of O_3 exposure on stomatal behavior, such that response to changes in environmental stimuli (e.g., PAR, VPD) is slowed. Although the speed of both stomatal opening and closing appears to be affected, oxidant exposure effects are more marked in stomatal closing. Oxidant exposure-induced reductions to plant carbon balance are well described, but ultimately, oxidant exposure effects may have more profound effects on plant water balance (increased drought stress), with repercussions at the multi-trophic level (greater susceptibility to insect attack), and ecosystem level (McLaughlin et al., 2007 New Phytologist 174:109).

We conducted a series of experiments with cultivated and native species to characterize O_3 exposure effects within physiognomic plant classes for the purposes of modeling. We used a custom exposure system that concurrently measures water, O_3, and CO_2 flux (Grulke et al., 2007) to expose portions of leaves to successively increasing O_3 concentrations, and at each concentration, test stomatal response to abrupt changes in light level. The abrupt changes in light were used to elicit a decoupling of Ps and gs as stomatal response was increasingly sluggish at higher O_3 concentrations. We expected to find that a lower O_3 concentration would elicit such a response in cultivated species, and that a higher O_3 concentration would be tolerated by uncultivated species, especially in highly drought tolerant species. To date, we have not been able to suggest within-physiognomic plant class commonalities. The cultivated species included snap bean, soybean, and sugar cane in greenhouse experiments. The uncultivated species included deciduous broadleaves (California black oak, European beech), evergreen broadleaves (Holm oak, blue oak), and evergreen conifers (ponderosa pine, loblolly pine) in greenhouse experiments with seedlings, field challenges within canopy at background and manipulated (CASIROZ) or O_3 gradient (San Bernardino Mountains) studies. The results of experiments with nine species are presented and discussed.

Terrestrial plant methane production and emission

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We evaluate all experimental work published on the phenomenon of aerobic methane (CH4) generation in terrestrial plants. We conclude that the phenomenon is true. Four stimulating factors have been observed to induce aerobic plant CH4 production, i.e. cutting injuries, increasing temperature, ultraviolet radiation and reactive oxygen species. Further, we analyze rates of measured emission of aerobically produced CH4 in pectin and in plant tissues from different studies and argue that pectin is very far from the sole contributing precursor. Hence, scaling up of aerobic CH4 emission needs to take into consideration other potential sources than pectin. Due to the large uncertainties related to effects of stimulating factors, genotypic responses and type of precursors, we conclude that current attempts for upscaling aerobic CH4 into a global budget is insufficient. Thus it is too early to draw the line under the aerobic methane emission in plants. Future work is needed for establishing the relative contribution of several proven potential CH4 precursors in plant material.

Relationship between Volatile Organic Compounds emission and antioxidant compounds in *Cistus monspeliensis* under drought and warming stress

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Volatile Organic Compouds (VOCs) emitted by plants have been proved to defence membranes against oxidative stress. Within this study we investigated VOC emission by *Cistus monspeliensis* that is one of the most abundant species in Mediterranean shrublands in both field and laboratory experiments. We focused our attention on the effect of drought and warming stress on VOC emissions. Plant physiological status was assessed using the leaf gas exchange technique and tenax traps for volatiles were collected and afterwards analyzed using GC-MS. The seasonal measurements in the field experiment, characterized by mild warming and drought treatments, did not show a clear response of Assimilation (A) and stomatal conductance (gs) to warming and drought treatments as compared to control. As for the VOCs emission the maximum emission was observed in winter and α-pinene was the most abundant monoterpene. We also grew plants in the growth chambers under stronger warming and drought treatment than those recorded in the field. Plants under drought stress showed a collapse of A, gs and intercellular CO_2 concentration (Ci) when the Fraction of Transpirable Soil Water (FTSW) approached a value of 35%. Moreover a decrease of the quantum yield of the photosystem II (ΔF/Fm') and a significant reduction on VOCs emission were detected under drought treatment. Regarding the antioxidant compounds, we observed that both treatments caused an increase in ascorbate (ASC) levels and in ascorbate peroxidate (APX) activity and a decrease in catalase (CAT) activity. However, the fact that warming treated leaves presented both higher levels of ASC and of CAT than drought treated plants by the end of the experiment, suggests that warming treated plants could have adapted better to stress conditions than drought treated ones as also shown by A and gs values.

Notes

Thursday, May 24
10:15 – 12:00

Session 11
Modeling and Risk Assessment

Chair persons:
Salim Belyazid and Wim de Vries

Evaluating forest stand transpiration from two perspectives - xylem sap flow measurement *versus* hydrological modeling

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Assessment of forest stand transpiration is an important factor to determine water consumption, limitation of plant-available water and risk of drought injury. Furthermore a realistic evaluation of stand transpiration is essential for assessing the phytotoxic relevant ozone dose and its risk for growth reductions of forest stands.

Stand transpiration for adult beech was investigated at six comprehensively instrumented and analyzed Bavarian Ecosystem Monitoring sites (Level II) differing by altitude, climate and soil type across Bavaria, Germany. At each site transpiration was measured with xylem sap flow sensors (Granier) on five dominant beech trees with high time resolution and modeled with BROOK90-LWF, a commonly used process-based model on stand hydrology.

In this study we compare the results from the two approaches to evaluate the stand transpiration determined from different perspectives – direct measurement via xylem sap flow in tree trunks and modeling based on climatic and edaphic processes. It was aimed to consolidate up-scaling of xylem sap flow to stand level water consumption and associated ozone uptake (deriving risk of O_3 injury), besides fostering validation of water budget modeling. The perspective is tool generation for realistic stand-level water balancing and associated O_3 dose-related risk assessment, based on a representative sample of individual trees as a starting point.

Comparing modeled ozone absorption with field measurements in a periurban Mediterranean forest

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Ozone absorption by urban trees has been estimated through modeling and field measurements in order to test, validate and parameterize the UFORE model developed in the United States.

We compared the ozone flux estimated by the UFORE-D Model with the ozone flux measurements using the Eddy Covariance technique in a periurban Mediterranean forest near Rome (Castel Porziano). Results show how the model overestimates ozone flux compared with the Eddy Covariance measurements because it does not account for stomatal limitation related to drought. The reason of this difference has been confirmed when the model was run with the values of stomatal conductance measured with Eddy Covariance instead of the ones estimated by the model.

Model sensitivity to specific parameters has been also tested in order to parameterize the model for the Mediterranean regions. In UFORE-D stomatal conductance for sunlit/shaded leaves in each layer is calculated using the Ball-Berry equation. Specific values for Castel Porziano of V_{cmax} (Maximum carboxylation rate when RuBP carboxylase/oxygenase is saturated), J_{max} (Light-saturated rate of electron transport) and m (the dimensionless slope in the Ball-Berry equation) have been used in the model in order to obtain the best fit for that Mediterranean forest. Then to test the sensitivity of the model to those physiological parameters, we investigated several values of V_{cmax} and J_{max} and for each couple of values we run the model changing the value of m from its minimum to its maximum. We analyzed model estimates versus tower measures and used the method of least squares to quantify differences between measures and D estimates day by day.

Preliminary results suggest that model estimates vary quite considerably at the change of V_{cmax}, J_{max} and m, obtaining the best fit when using typical values for the Mediterranean species and climate.

Diurnal trends in ozone sensitivity and effective flux in *Gossypium*: Key to modeling impacts?

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Parameterization of ozone (O_3) injury to vegetation will require consideration of three distinct stages: 1) O_3 entry to the leaf including fractionation of stomatal and non-stomatal deposition; 2) O_3 saturation of constitutive metabolic defenses; 3) oxidant attack by O_3 or derivatives on bioreceptors to produce injury. Ozone deposition at canopy and leaf scale are routinely obtained by observation or modeling. Injury can be assessed experimentally. Currently, the relationships between ozone concentration, ozone uptake (flux), and injury are not well characterized, due in part to uncertainties regarding ozone detoxification and its diel and seasonal variability.

We have developed a plant sensitivity parameter relating injury to O_3 flux during exposure. By restricting leaf exposure to a brief (15 min) pulse of O_3, we assess constitutive defense capacity, assuming insufficient time for generation of inducible defenses. Greenhouse grown Pima cotton was exposed in chambers to pulsed O_3 at a range of concentrations at different hours of the day. Stomatal conductance was measured pre- and post-exposure, and injury was assessed digitally 1 week later. The sensitivity parameter (S), determined at 2 hour intervals, exhibited clear diel trends, increasing to maximal sensitivity in late afternoon, with minimal sensitivity early and late in the photoperiod.

This diel pattern did not suggest that plant defense is correlated with instantaneous photosynthetic rate. There was only weak correlation between S and whole leaf measurements of ascorbate, ascorbate redox poise, or total antioxidant capacity.

The sensitivity parameter, S, represents an unbiased estimate of the weighting factor commonly used as a surrogate for plant defense in model relationships between injury and O_3 flux. Diurnally varying S can be combined with diel cycles of (measured or modeled) ozone concentration and stomatal conductance to yield integrated impacts of O_3 on injury to vegetation.

Impacts of changes in climate, nitrogen deposition, ozone and CO_2 exposure on forest carbon sequestration: a model assessment

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Carbon sequestration in forests and forest soils is influenced by various drivers including changes in climate (temperature and water availability), nutrient (nitrogen, base cations, phosphorous) availability, carbon dioxide (CO_2) exposure and ozone (O_3) exposure. We modelled the combined effects of past and expected future changes in those drivers on carbon sequestration in European forests and forest soils for the period 1900–2050. Forest inventory data around 2005 (EFI database) were used to assess reference forest growth rates, which were then modified for other years by factors accounting for deviations in climate and air quality compared to 2005. The impacts were evaluated using various assumptions with respect to interactions between drivers. Impacts of soil macro-nutrient availability (P, Ca, Mg, K) were also accounted for. The forest growth model was coupled to a soil model predicting nutrient availability and soil carbon sequestration.

Historical meteorological data were taken from a high resolution European data base that contains monthly values of temperature, precipitation and cloudiness for the years 1901–2000. Oxidised and reduced N deposition was calculated with the EMEP model. In addition, the ozone exposure in terms of a phytotoxic ozone dose (POD) was calculated by the EMEP model, incorporating the DO3SE deposition module, which parameterises ozone uptake as a function of phenology, light, temperature, humidity, and soil moisture. Historic NO_x, NH_3 and VOC emissions were taken from Lamarque et al., 2010. For the future (2010-2050) we used two scenarios for deposition (current legislation and maximum technically feasible reductions) and two climate scenarios (no change and SRES A1 scenario). Results of the simulations will be presented during the conference.

Effects of CO_2 enrichment and intensification of dry seasons on Amazon rain forest biomass and structure simulated by Troll model

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In tropical rain forests, the CO_2 atmospheric enrichment and intensification of the dry seasons are predicted to accelerate individual tree growth and to intensify the death rate, respectively. The TROLL forest dynamic model, calibrated and validated for the French Guiana Amazon Forest, allows individual based simulations of rain forests. The simulation of community dynamic and spatial pattern of plant distribution emerges from local interactions, in which trees compete for light. Six processes are simulated: seed dispersal, plant recruitment, light absorption and shadowing, tree growth, death and fall (gap formation). Twelve functional groups (pioneer, shade tolerant and light demanding, divided in maximum potentials stem heights) are described by different values of biological parameters: growth rate, death rate, leaf density, leaf area index, mature age, dispersal distance, seed dormancy, among others. Although light competition is the main drive force of the model, it can be adapted to simulate global changes. The TROLL model has been used to conduce simulated experiments in which the responses of a 22.5 ha virtual forest was analyzed. CO_2 atmospheric enrichment enhanced biomass yield and the mean stem diameter, but reduced the plants density and the dominance of shade tolerant and intermediate groups. Intensified drought events diminished forest biomass and the mean stem diameter. It increased plant density, but reduced the light demanding group dominance. When these two main effects of global changes were added together, the model indicated a less abrupt change, but still showed reduction in forest biomass and changes its structure and composition. The results are consistent with large scale field works. The model may be applied for simulation of tropical forest dynamics in response to any other atmospheric pollutant or climatic change, as O_3 and N deposition, although long term studies on the effects of these factors in tropical regions are still scarce.

Ozone data from passive samplers and AOT40 estimation in Italy

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The AOT40 index is the actual European standard to assess when and where ozone (O_3) concentrations exert a potential risk for vegetation. It can be calculated by using O_3 data coming from either automatic devices or passive samplers, offering thus practical advantages. The Loibl function describes the O_3 daily profile as a function of site elevation, relative altitude and day-time. The use of passive samplers and the Loibl function allow to calculate the AOT40 index everywhere. The question is: is the Loibl function working well in complex terrains as in most of the Italian country? In this work 89 monitoring stations (32 rural and 57 suburban) were analysed in Italy for the year 2005. AOT40 was calculated from hourly O_3 data measured by passive monitors, then, weekly concentrations were calculated in order to apply the Loibl function. Distance from the closest city, distance from the sea and minimum, maximum, and mean elevation around a 5 km buffer were calculated for each station by GIS. A model describing the O_3 effect on vegetation was developed by using a non-linear statistical method, based on the GLZ, with the main aim of understanding which among environmental parameters mentioned above are most important for O_3 concentrations. Residual between AOT40 estimated by the Loibl function and AOT40 measured by passive devices were high for each site, and in some cases the difference reached -241%. Elevation played a relevant role in affecting the AOT40 estimation. However, elevation does not act singly but only combined with others parameters. In fact it is an important predictor but it has not the same relevance for different station type and locations. AOT40 can be better predicted by using the non-linear approach such as the GLZ models.

Dynamic response of tree growth to changing environmental pollution

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Long-term investigations of Scots pine *(Pinus sylvestris* L.*)* growth were carried out in the vicinity of one of the biggest air pollution sources in Lithuania – mineral fertilizer plant 'Achema'. The main aim of the study was to analyze changes in radial tree increment at population and individual level occurring along with substantial reduction in air pollution, and to evaluate recovery capacity of the individual tree. Analysis of tree-ring series of Scots pine stands located at different distances from the pollution source has revealed that initial stages of dynamic tree response to the external stress factors which include an increased quantity of nutrients starts with stimulation stage, and is followed by a gradual transition to an exhaustion (depression) stage. A regeneration (recovery) phase starts after the stressor (air pollution) is substantially reduced and its intensity directly depends on stand damage intensity. Increased variability is characteristic to annual increment of damaged stands and even after its full recovery once destabilized system continues intensive fluctuations with reduced response to the impact of climatic factors.

Very high individual variability of the tree growth response was detected during the depression and recovery stages. Homeostatic mechanisms of the survived trees foster to reach approximately the same growth rate as that prior the depression period, therefore the tree growth rate prior the depression period serves as the most powerful predictor of tree growth recovery capacity under reduced environmental pollution. Crown defoliation is next the most important predictor of individual tree recovery capacity for heavy and moderately damaged Scots pine stands. Density of surrounding trees appeared to be statistically significant predictors of tree growth recovery capacity in the case of slightly and moderately damaged Scots pine stands.

Notes

Thursday, May 24
13:00 – 14:45

Session 12
“Potpourri”

Chair person: John King

Notes

Notes

Poster session

Chair persons:
He Shang and Vitas Marozas

Session 1: Air Pollution, Climate Change, and Forest Growth

Peroxides concentrations at two places in central Japan under global warming

Masatoshi Aoki[1], Ryota Marushima[1], Cattleya Chutteang[1], Prathomrak Na-Ngern[1], Mayuko Takeda[2], Fumiaki Takemasa[1],Ge Zhenrui[1], Buhe[1], Chen Xuan[3]
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Peroxides always co-exist with ozone because peroxides are formed by reaction with ozone and volatile organic compounds although the peroxides concentrations are mostly below several ppb. The peroxides are reported very harmful even in several ppb when these were combined with ozone (Chen et al., 2005; Chen et. al., 2010). We have been measuring at two sites in Tanzawa Mountains where beech forest has been declined, and at a site in Fuchu, Tokyo. Both places locate in central Japan. The aim of the present research is to compare the concentrations among three sites, and also recognize how the concentrations have been increasing. We measured in 2004 and 2009-2010 in the Tokyo site, and in 2009-2010 in two sites in Tanzawa Mountain. One of the Tanzawa Mountain sites locates on the ridge at 1002m above sea level (RG site), where severe beech forest decline occurs. The other locates on the slope at 952m above sea level (SP site), where forest decline does not appear, on the south slope below the first site. The results showed that the average concentration of Tokyo site in Sep.–Nov., 2004 was 0.3ppb, while in Sep. –Nov., 2009 was 1.2ppb. We also found that in 2004 the percentage of appearance above 1.5ppb (PA1.5) which causes severe plant damage, was about 30%, while that in 2004 was less than 1%. Then concentration in 2009 increased much than in 2004. The average concentration in RG site at Tanzawa in July－Oct., 2009 was 1.7ppb, and that in SL site was 1.2ppb. And PA1.5 in LG site was about 40%, while about 20% in SL site. Then it is concluded that recently peroxides concentration have been increasing, and peroxides concentration in Tanzawa Mountains are already above harmful level. These may be because of increasing air temperature.

Session 1: Air Pollution, Climate Change, and Forest Growth

GHG emissions seasonal response to different treatment of grassland ecosystems in the central Lithuania

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United Nations has identified anthropogenic forcing of climate change due to GHG annual increase of 0.4 (CO_2); 0.6 (N_2O) and 0.25 % (CH_4). Therefore it is becoming increasingly important to reduce the main driver of climate change, namely anthropogenic greenhouse gas (GHG) emissions in agricultural sector as well as in other human activities. This study evaluates GHG emission from grasslands subjected to different mineral treatment. The bioassay was conducted on two sites of different intensity management: abandoned for more than 20 years grassland (54°88′ N, 23°84′ E) and intensively managed cultural pasture (54°87′N, 23°83′ E) located at Aleksandras Stulginskis University, Kaunas district, during vegetation period applying chamber method. The soil of both sites was clay loam topsoil over silt loam (*Calc(ar)i-Endohypogleyic Luvisol*).

Climatic conditions, namely temperature and humidity, strongly (r=0.9) impacted the rates of GHG emissions during vegetation. The lowest CH_4 emission was observed in grasslands, probably due to well drained soil conditions. The most favourable vegetation conditions in June resulted in the highest GHG emission (0.045 mg h^{-1} m^{-2} N_2O, 23.49 mg h^{-1} m^{-2} CO_2 and 0.06 µg h^{-1} m^{-2} CH_4) in semi natural grassland. Gradual decline of GHG fluxes was observed during vegetation, in accordance with depletion of environmental components encompassing organic substrates, fertilizers, activity of microorganisms, as well as their interaction with humidity and temperature.

A strong correlation was detected between mean N_2O, CO_2 and CH_4 emission during the vegetation period on the one hand, and NPK (r=0.9, 0.8 and 0.9) or monomial nitrogen supplement (r=0.8 and 0.6) on the other. Consequently, appropriate and environmentally sustainable nutrient rate for supporting soil fertility and contributing to significant driver of climate change – anthropogenic GHG emission reduction – should not exceed $N_{60}P_{40}K_{50}$ for semi natural grassland in the central Lithuania.

Session 1: Air Pollution, Climate Change, and Forest Growth

The relationship among climate change, N-supply and sessile oak decline

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As consequence of climate change, elevated CO_2 and nitrogen deposition an accelerating tree growth has been observed in West- and North-Europe. The extra yield seems to bee unsignificant in the southern and eastern regions of the continent due to more frequent dry periods. Since the 70's severe dry periods triggered mass mortality of stand forming forest tree species (*Quercus petreae, Quercus robur, Picea abies, Pinus sylvestris, Pinus nigra and Fagus sylvatica*) in the Carpathian-basin.

The poster presents the resulting health condition (current stand density) of sessile oak stands in Hungary. The effect of the dry extreme events is the last four decades and the role of extra N loads were investigated. How the different N-deposition influenced the drought tolerance of trees?

The health status of the forests are detected only by the living trees in the forest monitoring across Europe, which does not take into account the number of died trees.

The quantity of died trees dried out in the last decades are indicated by the current density of the forest stand. Stand density, wood volume and current health condition of the remaining trees of the stand situated close to the optimum growing sites, and growing near to their xeric limit were compared. The nitrogen content of the soil and the leaves were measured. The dendrometric parameters of the stands were also compared with the data of the yield tables edited in the 60's, when there was lower CO_2 concentration, N-deposition and arid periods were not so frequent, than in the last four decades in the Carpathian basin.

Preliminary results suggest a higher wood product of the survived trees, but the total volume of the thinned sessile oak stands are decreased.

Session 1: Air Pollution, Climate Change, and Forest Growth

Forest roads planning and construction in Turkish forestry

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Forest roads are necessary to provide access to the forest for general management, maintenance, timber extraction and recreation. The forest roads building for the Turkey forests to facilitate timber harvest and attainment of other multiple use objectives requires a high capital investment. A mistake in planning a road, such as ignoring the effects of environmental and other parameters, leads not only to the waste of public investment, but also to adverse environmental impacts and increase maintenance costs. Forest roads have been planned and constructed according to road density (m/ha) and yield/forest area (m^3/ha) criteria to meet the needs of Turkish forestry. However, forest road density should be determined according to all aspects of forestry operations. All the research done in Turkey has stated that forest road density may be 20 m/ha. Total identified forest road needs in Turkey are 201810 km, of which 143251 km, or 70.98%, had been constructed by the end of 2007. 70.98% of forest roads, 69.80% of firebreaks, 52.24% of major repairs, 51.67% of paving, 58.28% of bridges, and 64.82% of forest road structures which were planned to be constructed by the end of 2006 had in fact been completed. It is intended that the construction of all planned forest roads and the completion of all associated structures will be achieved within 20 years. In Turkish forestry system, road planning and building process can be partitioned into network planning, transferring network from the plan to the ground, mapping, data processing and sections design, right-of-way felling, pioneering, right-of-way logging, clearing and grubbing, excavation and embankment, subgrade finishing and surfacing. Nowadays the GIS techniques have been suggested to design the optimal forest road network in Turkey. The GIS and computerized analyzing by NetCAD, Netpro and InRoads software's helps to economize time, work power, costs and to minimize environmental damages.

Session 1: Air Pollution, Climate Change, and Forest Growth

Long term dynamics of biotic and abiotic damages of forest ecosystems in Strandza Mountain (Southeast Bulgaria) in relation to climate change.

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The present research was carried out in Strandza Mountain, which is situated in the furthermost southeast corner of Bulgaria. Because of the specific climate of this region the deciduous broad-leaved forest vegetation is similar to the Ponto-Euxine vegetation of the Caucasus. The forests consist mainly of *Quercus* species. The aim of the study was to reveal the long term dynamics of damages on the forests caused by biotic and abiotic factors, and to possibly relate them to climate change. Old records and historical data on pests, diseases, defoliation, floods, fires and others were gathered and analyzed. Characteristic patterns in the dynamics of damages, caused by different factors were identified. Some of them could be related to climate parameters as were defoliation and drying of forest to droughts, pest to floods et. Other characteristics could not be correlated to climate. Some patterns could be explained by land use practices.

Session 1: Air Pollution, Climate Change, and Forest Growth

Tree-ring based May–June precipitation reconstruction for southwestern Turkey and its links to volcanic eruptions

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A high quality May–June precipitation reconstructions for inner part of south-western Turkey was performed using a tree–ring data from western Turkey. Two separate reconstructions were developed to accommodate the varying chronology lengths. The first reconstruction uses all site chronologies with a common interval AD 1823–2004. The second reconstruction uses only four of the chronologies with a common interval AD 1692–2004. R^2 values of the reconstructions are 0.64 and 0.51 and RE values 0.63 and 0.51. For the reconstructed period (1692-1938), 41 dry (-) and 48 wet (+) events were determined. The very dry years were 1725, 1814, 1851, 1887, 1916 and 1923, and the very wet years were 1736, 1780, 1788, 1803 and 1892 around Burdur. The longest driest period was 16 years long (1860–1875). This reconstruction revealed past dry and especially wet years with more reliable results. Moreover, our research investigated the relationships between reconstructed rainfall patterns and major volcanic eruptions in Turkey. The year of largest explosive volcanic eruption or the year following eruption, or both is found as wet years in the reconstruction.

Acknowledgements. This study was supported by The Scientific and Technical Research Council of Turkey (TUBITAK), Project ÇAYDAG 107Y267.

Session 1: Air Pollution, Climate Change, and Forest Growth

The temperature and precipitation effects on the annual linear Scotch pine increment on the banks of Kandalaksha bay.

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The dependence of Scotch pine linear increment on climatic parameters was considered. The investigation took place on the territories of Kandalaksha state nature reserve and the complex wildlife reserve “Polar circle”. Arid, fresh and wet biotopes were investigated. In all habitats no similar interrelations between increment and temperatures were found out. Also no analogous increment responses to meteorological factors in fresh sites was noticed. For arid and wet sites significant correlations of age trend variability and precipitation amount ranks were identified. A conclusion was made that in wet and arid biotopes the precipitation amount appears to be the limiting factor for Scotch pine.

Session 1: Air Pollution, Climate Change, and Forest Growth

The effects of elevated air humidity on the development of silver birch (*Betula pendula* Roth) foliage in an experimental forest ecosystem

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Climate change scenarios predict mostly an increase in precipitation for northern Europe in the future. However, the effects of increased precipitation, cloud cover and air humidity on the growth and development of trees are relatively unstudied in comparison to those of rising CO_2 levels and temperature, particularly in field conditions. Tree foliage develops by the births, growth and deaths of buds, incipient shoots bearing embryonic leaves. Environmental cues affect the number, size, spatial arrangement and developmental routes of buds resulting in variations of species-specific patterns of tree growth. As the structure of foliage affects essential physiological processes such as photosynthesis and transpiration in individual trees, the changes in foliage structure may also impact the functioning of ecosystems. We examined the effects of elevated air humidity on the development of silver birch (*Betula pendula* Roth) foliage in an experimental forest ecosystem at the free air humidity manipulation (FAHM) facility located in Rõka, Estonia. We collected data on shoot characteristics, bud size and number over three consecutive years, and measured the leaf area on current-year shoots. Our data indicate some negative effects of elevated air humidity on the development of silver birch foliage, mainly a decrease in bud size. However, that did not always translate into smaller leaf area per current-year shoot due to indeterminate shoot growth.

Session 1: Air Pollution, Climate Change, and Forest Growth

Relationship between tree ring changes of two co-existing oak species and climate from North Hungarian Central Range, Hungary

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Mixed forests of sessile oak (*Quercus petraea* (Matt.) Liebl.) and turkey oak (*Quercus cerris* L.) cover the largest part of forested area in Hungary. This study was performed at an LTER site (North Hungarian Central Range, established in 1972) situating at the xeric margin of distribution area of this forest type. The site is vulnerable to current climate change that gives an interesting aspect of tree ring analysis on the canopy tree species.

Increment cores were taken from 81 trees of *Q. petraea* and 18 trees of *Q. cerris* in November, 2010. From the 100 year long chronology of the two species we have selected a 20 year long period (1973-1993) in order to make a detailed climate-growth analysis. Two main climatic parameters (monthly mean temperature and total rainfall) and different indices (Goussel-Bagnouls, Ellenberg and Pálfai) were used for description the ecological and climatic conditions of the selected years.

In analysis of relationship between the growth increment and temperature or rainfall we used meteorological data of a 16 month long period (from previous June to current September). *Q. cerris* produced significantly larger annual increment between 1976 and 1989 compared to both the previous years and to *Q. petraea*. This period was described with serious tree decline at the site similarly to other oak forest stands in Hungary. Correlation analysis revealed that temperature in the previous and current summer periods higher than the long-term average had negative impact on both species while the rainfall of previous autumn and current spring influenced positively the tree ring development. *Q. cerris* showed stronger correlation with climatic parameters than *Q. petraea* which reflected larger climatic sensitivity of turkey oak compared to the co-occurring sessile oak. The study was supported by national and EU research funds: OTKA No. 68397 and TÁMOP-4.2.2/B-10/1-2010-0024, Life08 ENV/IT/000399.

Session 1: Air Pollution, Climate Change, and Forest Growth

Meteorological factors and Norway spruce (*Picea abies* (L.) H. Karst.) condition in the habitats with different site humidity

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Norway spruce (*Picea abies* (L.) H.Karst.) has been declared as the most sensitive species to climate change. With the rise in average temperature 0.7-0.9 ^{0}C during the last century and especially significantly in the last 2-3 decades winters became warmer with the increased amount of precipitation, summers - with severe droughts. The aim of study was to determine possible effects of meteorological factors on crown condition of Norway spruce in the habitats with different site humidity.

The data from Lithuanian regional forest monitoring (1989-2010) have been used. Crown condition of Norway spruce (defoliation D and the proportion of healthy trees H) has been assessed annually for 2000 trees on average. Trends of crown condition and correlation between crown condition and meteorological factors (average temperature, amount of precipitation and hydrothermal coefficient of Selianinov (HTC)) have been analysed in the habitats with different site humidity index (N – normal moisture; L – temporarily overmoist; U – permanently overmoist; P – bogs).

In many cases the correlation between meteorological indices and crown condition was stronger and more reliable in habitats with normal humidity (N) than in habitats U (overmoist) and P (bogs). In habitats of high humidity (U+P) along with increasing HTC and amount of precipitation the crown conditions worsened.

Our results suggest, that neither increased winter temperature, no the increased annual temperature have negative effect on Norway spruce crown condition in Lithuania; we believe that droughts over the vegetation period are a more significant factor on Norway spruce condition deterioration.

Session 1: Air Pollution, Climate Change, and Forest Growth

The influence of climate factors on Scots pine (*Pinus sylvestris* L.) seasonal height growth dynamics

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For young trees annual height increment is one of the main indicators, which defines their productivity and competitiveness. Trees at early stages of development are more vulnerable to changes in meteorological conditions later on. According to climate-change scenarios, increase of mean annual temperature in territory of Latvia until the end of the century is predicted to reach 2.5 °C and be especially pronounced during winter months. Notable changes in distribution of precipitations during vegetation period, which could cause prolonged droughts and showers with very high intensity, are predicted. Projected changes could be unfavorable for juvenile tree growth. In order to provide better understanding on how the predicted changes could affect height increment of Scots pines, associations between meteorological variables and seasonal height growth dynamics were studied. Height increment was measured with interval 7 days on average from April until July during 5th growing season in open-pollinated progeny trial (altogether 60 families) of Scots pine located in the northeast part of Latvia (Smiltene). Information was gathered from 1187 trees in total. The results demonstrated that height growth was positively correlated with precipitation in the growing season, but no significant and very strong association between height growth and temperature was found.

Session 2 "Atmospheric Deposition, Soils and Nutrient Cycling"

Comparative study on the stability of soil organic carbon in forest and agroecosystems

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The aim of this study was to assess the stability of soil organic carbon (SOC) in *Arenosols* within three different arable land uses: (1) continuously cultivated land; (2) abandoned land; and (3) afforested with Scots pine (*Pinus sylvestris* L.) or silver birch (*Betula pendula* Roth). Total SOC and SOC in different soil fractions were estimated, and carbon (C) in the mass of soil microbiota was determined in mineral topsoil. Despite the highest concentrations of labile C, mineral topsoil after afforestation, especially with birch, contained the highest concentrations of total SOC (across all land uses varied in low range between 7.5 and 14.7 g kg^{-1}) and the highest C concentrations of 53-250 µm organic matter fraction in comparison with arable and abandoned arable land. That could be related with the accumulation and decomposition of soil organic layer in forest plantations. Thus, in 0-20 cm mineral soil layer in *Arenosols* mean carbon concentrations in microbiota biomass (C_{bio}) ranged from 20 to 100 µg g^{-1}. Thereby such low C_{bio} concentrations could be followed upon/by the intensively decomposed organic matter in *Arenosols*. Nonetheless, the C_{bio} concentrations were the lowest in pine plantations, the highest in birch stands and intermediate in arable or abandoned arable land. The obtained data supported Kyoto protocol resolution: the afforestation of arable land on nutrient-poor sandy soils in Lithuania could be relevant with the focus on C sequestration. Meanwhile such afforestation should be coherent with the conservation of biodiversity and traditional landscapes.

Acknowledgement. The research was funded by a grant (No. MIP-038/2011) from the Research Council of Lithuania.

Session 2 “Atmospheric Deposition, Soils and Nutrient Cycling”

The influence of fallow deer kept in enclosure on soil chemical properties

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The introduction of new species represents a threat to the stability of ecosystems, populations and communities. Herbivores can have important direct and indirect effects on belowground properties and processes that govern ecosystem structure and productivity. Little information is available on the impact of fallow deer on soil chemical properties. In this study, we examined the effects of fallow deer kept in *enclosures* on soil chemical properties. The study was carried out in enclosures at the Anyksciai, Panevezys, Kaisiadorys and Raseiniai State Forest Enterprises. Spruce, mixed spruce and birch stands dominated in enclosures. We collected soil samples (0-20 cm soil layer) in enclosures and in nearby stands outside enclosures as controls. We measured pH, organic C, mineral N-NH_4^+, N-NO_3^- and mobile PO_4^{2-}. The results revealed that soil pH in *enclosures was lower (6.11), than that outside the enclosures (6.85). Total soil organic* C and phosphorus did not differ between soil in enclosures and outside them. Mineral nitrogen (N-NH_4^+, N-NO_3^-) was higher in *enclosures than outside them.* The significant effect of fallow deer on soil nitrogen has the potential to reduce ecosystem productivity.

Session 2: Atmospheric Deposition, soils and nutrient cycling

Growth of Scots pine, Norway spruce and Siberian larch trees under the effect of changing nitrogen emissions and climatic condition

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Three different coniferous tree species were investigated in a planted stand located close to the nitrogen fertilizer plant JV 'Achema': Scots pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* Karst.) and Siberian larch (*Larix sibiri*). Variable effects were observed on the growth of these tree species. Scots pine trees prevailing in Lithuania were most sensitive to high nitrogen pollution level at the beginning of the 1980s. In 1979, when the emissions of the plant exceeded 70 thousand t, after a very cold winter pine trees in most cases did not form tree rings. Decrease in tree ring width of Norway spruce was significant but reached only about 40% of the previous ring widths. Larch trees seemed to be the most resistant to cold winters and high nitrogen pollution level. Increase in tree ring width was only 10% demonstrating natural width reduction with ageing process. When the emission load decreased the most intensive tree growth recovery was detected for Scots pine trees. Meanwhile the increment of Norway spruce trees continued to significantly decrease further for about 15 years and only more recently started increasing. Data on the effect of climatic conditions on tree ring formation revealed that the growth of the considered tree species were limited by heat from June through July; in addition for pine trees - by frost from February through March, and for Spruce trees – by drought from May through June. These results show that Scots pine is the most sensitive tree species in response to pollution and frost compared to the other species; yet their recovery after stress is the most intensive as well. Norway spruce is not so sensitive to pollution level, but the effect of unfavourable environmental conditions continues longer and the processes of increment decrease as well as increase occur more slowly and gradually than those of pine or larch trees. Larch trees seem to be the most resistant to air pollution but the most sensitive to heat from June through August in comparison to Norway spruce and Scots pine trees. These tree characteristics should be taken into account when considering aforestation of areas under the impact of emissions from nitrogen fertilizer plants.

Session 2: Atmospheric Deposition, soils and nutrient cycling

Rainfall modification in mountainous ecosystems dominated by *Fagus silvatica* and *Picea abies* (Western Balkans, Bulgaria): an assessment by multivariate analyses

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Bulk precipitation, throughfall and stemflow samples were collected in the Petrohan area (Western Balkan, Bulgaria) during a six-year period. This mountain area is characterized by the presence of beech and spruce forests (*Fagus silvatica* L. and *Picea abies* Karst) and is utilized for drinking water supply. All samples were analyzed for pH and major inorganic anions (Cl^-, NO_3^- and SO_4^{2-}) and cations (Ca^{2+}, K^+, Mg^{2+}, Na^+ and NH_4^+). Results showed that the bulk precipitation in this region was mainly acidic (pH = 5.1) and the acidity was mainly due to NO_3^- and SO_4^{2-}.

The calculation of the Neutralization Factor (NF) showed that Ca^{2+} and NH_4^+ were the dominant neutralization components in rainwater. The high percentage (>75%) of the non-sea salt fraction (nssF) showed that Ca^{2+}, K^+, Mg^{2+}, Cl^- and SO_4^{2-} were not from a marine source. The Fractional Acidity (FA) average value of 0.062 indicated that about 94% of the acidity was neutralized by alkaline constituents. Cluster Analysis (CA) and Principal Component Analysis (PCA) were used for studying the correlation structure between the variables measured and investigating the possible sources contributing to the chemical composition of the bulk precipitation. Moreover, the possible modifications of the bulk precipitation during its passage through beech and spruce stands were also investigated. Results pointed out that local and long-range transport related anthropogenic sources and natural sources contributed to the anions and cations measured in bulk precipitation. The enrichment of throughfall solutions by dry deposition as they passed through the canopy was significant in both stands, but foliar leaching processes were much greater in the spruce forest, especially for Ca^{2+}. Stemflow followed the same pattern as throughfall but N uptake and a strong K^+ and Mg^{2+} leaching were observed in the spruce stand.

Session 2: Atmospheric Deposition, soils and nutrient cycling

Trends in Atmospheric Deposition in Czech Forests

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Profound socio-economic changes in Central Europe in 1989 resulted in significant improvement of many environmental indicators. Severe air pollution, ranking the former communist Czechoslovakia among the most polluted European countries, decreased substantially. This contribution presents the temporal trends and spatial patterns of sulphur and nitrogen deposition in Czech mountain forests in 1990–2008. For the analysis we used the data from sites of the nationwide monitoring network operated by the Czech Hydrometeorological Institute. Our results reveal many significant changes over the period observed, not only in concentrations of respective ions but also in the proportion of ions in precipitation. This for example applies to the ratio between sulphates and nitrates, used in the past as a logical check of the chemical analysis. Whereas this ratio used to be approximately 2:1 (SO_4^{2-} : NO_3^-) before 1989, we have been observing coincidental gradual SO_4^{2-} decrease and NO_3^- increase. The NO_3^-/SO_4^{2-} ratio shows statistically significant increasing trend for all types of Czech sites, with the most prominent change in mountain forests. The above development is consistent with the changing trends in SO_2 and NO_x emissions. We observe a statistically significant increasing trend in pH of the precipitation at all types of sites. The spatial patterns of the annual total deposition flux of sulphur reveal that in most parts of the CR sulphur is not a problem any more. In contrast the annual total deposition flux of nitrogen still represents in many regions a considerable stress. The value of 1 g.m^{-2}.year^{-1}, the critical load set up for Central European coniferous forests, is exceeded over a significant portion of the country. Moreover, as the deposition from fog, low clouds and rime is neglected in our models due to methodological reasons and significant uncertainties, we can reasonably assume even higher deposition fluxes than currently reported, particularly in mountain regions.

Session 2: “Atmospheric Deposition, soils and nutrient cycling”

Effect of mineral fertilization on soil enzymatic activity of spruce younger age classes in the Beskid Śląski and Żywiecki Mts.

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This study was carried out on experimental plotsestablished in the mid-montane zone (altitude of 900-950 m above sea level) using structured blocks. Research was carried out in triplicate with surface fertilization of soils in spruce stands of younger age class (20-40 years) with grated serpentinite in combination with mineral fertilizers (NPK). In autumn 2008 triplicate plots 10x10 m in size were manually treated with grated serpentinite (S) in the quantity of 4000 kg ha-1 and 2000 kg ha-1 respectively. Soils in the Beskid Slaski Mountains are haplic arenosols subjected to severe impacts of industrial pollution. In the Beskid Żywiecki Mountains the soils are haplic cambisols exposed to moderate deposition of pollutants. In spring 2009 ammonium nitrate (N) in the amount of 150 kg N ha-1, triple superphosphate (P) in the amount of 80 kg P ha-1 and potassium sulphate in the amount of 110 kg K ha-1 were applied manually. The following fertilization treatments were used: C - control without fertilization, S-serpentinite, SN - serpentinite plus nitrogen, SP - serpentinite plus phosphorus, SNP - serpentinite plus nitrogen and phosphorus, and SNPK - serpentinite plus nitrogen, phosphorus and potassium. Soil samples were collected for testing in mid-August in the years 2009 - 2011 from the first three soil horizons (A, AE or AB and B) to 30 cm depth. The activity of dehydrogenases, urease, β-glucosidase, and phosphatases was determined. The effect of the fertilization treatments on enzyme activity was analyzed by non-parametric test of Kruskal - Wallis. A significant effect of fertilization on enzymes activity was found in the years 2010 and 2011. An increase as well as inhibition of enzymes was noted, depending on soil type, dose of serpentinites, fertilization treatment, soil horizon, and level of pollutant deposition.

Session 2: Atmospheric Deposition, soils and nutrient cycling

Erosion Processes Caused by Logging in Mountain Areas: The Wilczy Potok Valley Case Study in the Silesia Beskid

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The end of the 20th century saw the beginning of the process of intensive disintegration of spruce stands in the Silesia Beskid. The consequence of this phenomenon was the necessity to make sanitary cuttings and remove vast volumes of trees. Because of the volume of timber that had to be transported out of the region on a mass scale, heavy equipment for skidding was used. This paper presents the observations and measurements of erosion gullies which were formed as the result of logging performed in the Wilczy Potok Valley located in the Silesia Beskid.

At the end of 2011, compact forest stands already covered only 10% of the area of the valley, while in the 1980s such forest stands covered over 85% of the valley. The valley, covering an area of 130 ha, is located at 580 - 840 m a.s.l. As the result of observations, 40 erosion gullies have been recorded with an aggregate length of 6540 m. Ten gullies had their cross-sections measured in order to assess the scale of erosion caused by logging. On the basis of the obtained results it was determined that logging in the valley rapidly accelerated erosion processes which may lead to changes in hydrologic conditions within the valley.

Session 2: Atmospheric Deposition, soils and nutrient cycling

The influence of selected properties of the forest environment on the level of heavy metal accumulation in the soil surface layers in the immediate vicinity of the Bolesław Mine and metallurgical Plant in Bukowno (southern Poland)

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The paper presents analysis of the level of accumulation of selected heavy metals in the surface soil layer in forests located in the vicinity of the Bolesław Mine and Metallurgical Plant in Bukowno, which mines and processes zinc and lead ores. In autumn 2010, 33 experimental plots were set up in the area in question, in a regular grid of 500 m x 500 m within the radius of up to 2 km from the centre of the sedimentation tank of the Bolesław Mine and Metallurgical Plant. On each plot, the layer of (Olfh) litter and the surface soil layer (0 – 20 cm) were sampled. In the samples, the following properties were determined: the heavy metal content (Zn, Cu, Pb, Cd, Ni, Cr) with the use of an AA 20 Varian atomic spectrometer, and the basic soil properties (pH, grain size composition, hydrolytic acidity, sorptive complex and organic matter content). The azimuths and distances of the examined sample plots from the sedimentation tank and the mine as well as the density, species composition and age of the stand were determined. Statistical analyses were performed with the use of the STATISTICA [StatSoft 2009] software. Moreover, the ArcGIS ESRI software was used to prepare maps showing the distribution of concentrations of individual heavy metals in the litter and soil layers with the use of the Inverse Distance Weighted method of interpolation.

The aim of the present study was to determine the influence of selected properties of the forest environment on the level of heavy metal accumulation in the soil surface layer. The research showed very high concentrations of Zn, Pb and Cd both in the litter layer and in the soil surface layer, which demonstrates that the examined area is one of the most polluted locations in Poland. The amount of the accumulated heavy metals was determined mainly by such parameters as: pH, organic matter content and grain size composition as well as, to a smaller degree, stand density, hydrolytic acidity or the degree of base saturation of the sorptive complex.

Session 2: Atmospheric Deposition, soils and nutrient cycling

Deposition of ionic constituents and black carbon in East Asian forests

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Particulate matter deposited on leaf surfaces may cause erosion/abrasion of epicuticular wax and malfunction of stomata. The deterioration of the leaf surface structure may accelerate uncontrolled water loss, ion leaching/uptake, and infection of fungi/bacteria. However, deposition process of particulate matter, such as black carbon (BC), has never been studied in forest ecosystems. Deposition of ionic constituents and BC was studied in a Japanese cedar forest at the Kajikawa site in Niigata Prefecture, Japan, and in a dry evergreen forest at the Sakaerat site in Nakhon Ratchasima Province, Thailand. The climate of Niigata is humid subtropical (precipitation, ca. 2300 mm) and the area has strong effects of seasonal winds. The climate of Nakhon Ratchasima is tropical savannah (ca. 1400 mm), which has distinct wet and dry seasons. Deposition of ion constituents by rainfall outside forest canopy (RF), throughfall (TF) and stemflow (SF) was measured biweekly or twice a month. Additionally, particulate matter in RF and TF were collected directly on quartz filters in the field using filtering-type bulk samplers. Moreover, particulate matter strongly adsorbed to leaf surface (leaf aerosols) were extracted by chloroform and collected on quartz filter. Ion constituents in the rainwater samples were determined by using an ion chromatograph and BC on the filters was determined as elemental carbon by using an OC/EC Carbon Analyzer. Deposition of ion constituents in both sites showed a distinct seasonality, increasing from autumn to winter by seasonal west winds in Kajikawa and increasing in the beginning of the wet season in Sakaerat. The BC deposition by RF and TF showed a similar seasonality in Kajikawa. However, the deposition by TF was frequently lower than that from RF in Sakaerat. Leaf aerosols may also contribute to the BC deposition in particular in Sakaerat.

Session2 “Atmospheric Deposition, Soils and Nutrient Cycling”

Impact of shelterwood cuttings on soil nitrogen in pine forests

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The aim of the study was to determin the impact of shelterwood cuttings on soil nitrogen in pine forests. The study was conducted in Jonava pine forest cutting areas, aged 1, 3, 5, and 7 years, the first stage of shelterwood cuttings, and in areas close to cutting, in mature pine forests (control). Soil samples were collected in cutting areas, where *Calamagrostis epigeios* L., *Calamagrostis arundinacea* L. and other herbaceous vegetation were growing. The amounts of total nitrogen, ammonium nitrogen ($N\text{-}NH_4^+$), and nitrate nitrogen ($N\text{-}NO_3^-$) from the soil layer of 0-20 cm were determined in the laboratory under ISO standards and approved methodologies. The results revealed that both total and mineral nitrogen showed highest variation within 1 and 3 years after shelterwood cuttings. In older cutting areas total and mineral nitrogen were similar to those of uncut areas. The amount of ammonium nitrogen was lower in cutting areas than in uncut areas, while the amount of nitrate nitrogen showed an opposite trend. During the stabilization of forest ecosystem after cuttings, the amount of ammonium nitrogen increased, while that of nitrate nitrogen decreased. The impact of various dominant species of vegetation on the amount of nitrogen compounds was not well pronounced or distinct.

Session 2: Atmospheric Deposition, soils and nutrient cycling

Differences in PAHs deposition to leaves of *Quercus robur*, *Betula pendula*, and *Pinus sylvestris*

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This investigation was carried out in mixed forests in the vicinity of the “Konin” Aluminium Smelter and in Mirachowo (Northern Poland – “clean area”). The concentration of PAHs in the air was calculated on the basis of measurements using diffusive passive samplers (silicon absorbent). Deposition of 17 PAHs was determined in leaves of oak (*Quercus robur)*, birch (*Betula pendula)*, and pine (*Pinus sylvestris)*, and the amount of these compounds in litterfall of particular species was also assessed. The concentration of PAHs in the air was 20 times higher in industrial area when compared to the clean region. Birch leaves showed the highest efficiency in the accumulation of PAHs. The deposition of PAHs to leaves showed a good correlation with the amount of waxes on leaves of individual species. The highest amount of PAHs with litterfall reached the soil under oak.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Level II forest monitoring in Latvia

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There are 1.02 billion hectares of forest in Europe, which amount to 25 percent of the world's total. Over the last 20 years the forest area has expanded in all European regions and has gained 0.8 million hectares each year. Climate change is expected to have a strong effect upon tree species distribution of these forests. Forest condition in Europe is monitored since 1985 within the scope of two-level system of ICP Forests (International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests). In its history of over 20 years the ICP Forests programme has developed into one of the world's largest biomonitoring networks. The results provide information on forest health, air pollution, climate change and biodiversity. General information on forest health status is annually recorded on so-called Level I monitoring sites. More intensive investigations are conducted on Level II sites. Implementation of the Level II forest monitoring in Latvia was initiated in 2004 by establishment of a single monitoring plot in the southern part of the country (Jelgava municipality). Characteristics of the forest stand are: growing stock of timber 289 m^3 ha^{-1}; density index 0.9; site index II; stand age 81 year; forest type *Myrtillosa*. The first floor of trees consists of Scots pine (*Pinus sylvestris* L.). Norway Spruce (*Picea abies* (L.) H.Karst.) dominates in the second floor. Presently regular measurements are carried out for following parameters: visual assessment of crown conditions, analysis of chemical and physical properties of soil, analysis of needles and leaves, estimation of growth and yield of woody plants, analysis of soil solution and deposition and assessment of ground vegetation. Since 2009 the measurement program is extended by monitoring of air quality, assessment of ozone injuries and analysis of litterfall.

The authors of the publication are expressing their gratefulness to the project No 2010/0199/2DP/2.1.1.2.0/10/APIA/VIAA/021 financed by the European Regional Development Fund for support of the publication.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Reaction of the Scots pine (*Pinus sylvestris* L.) population to industrial pollution *manifested in level of morphological and anatomical needle traits* differentiation and coefficient of fluctuating asymmetry (FA)

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In a naturally regenerated Scots pine populations growing in stress conditions can be observed different reactions. One of it was indicated by fluctuating asymmetry, a peculiar measure which expresses the response of Scots pine needles to pollution. In these studies the two categories of tree damage were distinguished, differing significantly with regard to the possibility of tolerating pollution. The following features were discerned in the group of pollution-tolerant trees: lower FA, longer needles, larger number of stomata on the axial side of a needle, increased *thickness* of the *cuticle* layer with epidermis as well as larger number of resin canals. The observed differences in combination with such parameters as growth, persistence of needles, production of seeds and their ability to germinate point to a disparate reaction to pollution among trees of the same species. Obtained the higher level of variability of the features in group of tolerant trees, it could be assumed that those differences caused better adaptation of the Scots pine to an area polluted by heavy metals and other stressors. It is probably one of the signs indicating the alterations in the genetic structure of the Scots pine population in the process of natural regeneration in the industrial areas.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Stomatal Ozone Fluxes to Trees: Methodology for Air Quality Regulations to Protect Vegetation

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Among air pollutants, ozone is recognised as the most damaging to plants. Plant protection regulations in the European Union are based on an exposure index derived from ozone concentration data, but recent evidence shows that the physical parameter governing damage to vegetation is the flux of ozone through the stomata. Correct measurements and models of stomatal ozone uptake by vegetation are thus essential to develop a new approach for plant protection.

This work compares three measuring methods aimed at determining ozone stomatal fluxes over a beech stand. The first two methods, eddy covariance and sap flow measurements, use water vapour fluxes as a proxy, since the latter are directly related to the stomatal fluxes of ozone. The third method is a direct measurement using dynamic leaf cuvettes.

The measurements were conducted at the Kranzberg Forest site in southern Germany, where an important permanent facility, specifically designed for forest health studies, is installed. Eddy covariance observations of ozone and water vapour flux were performed using sonic anemometry coupled with the use of fast-response sensors. The sap flow through the beech trees recorded using the heat flow deformation technique; direct measurements of the ozone stomatal flux were carried out with leaf enclosures and a controlled ozone flow. Results show a fairly good agreement between the three methods.

Air quality regulations level require correct description of processes leading to reduction of plant growth as well as to other physiological adverse effects, due to the phytotoxicity of certain air pollutants. The flux-based method is particularly well-suited for that purpose and should be included in legislations aimed at protecting vegetation at international level.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Predicting tree crown defoliation using conventional for Lithuanian forest inventory color-infrared orthophoto maps

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Orthophoto maps based on color-infrared aerial photography have been used in Lithuanian forest inventory since 2001. Although the techniques employed to capture the images have changed significantly during the decade, the final product remains the same – digital color orthophoto map with green, red and near infrared spectral bands, standardized image enhancement procedures and 0.5x0.5 m ground sampling density. This study aimed at investigating the possibilities to predict tree crown defoliation using the color-infrared orthophoto maps, conventional for Lithuanian forest inventory. Test area in Aukstaitija National park, located in Eastern Lithuania was photographed in summer of 2008 using Vexcel UltraCam D digital frame aerial camera to produce the orthophoto maps. 1793 tree crowns (mainly pine, spruce and birch) located on 47 permanent sample plots were identified and delineated on the orthphoto maps. Crown defoliation and other dendrometric characteristics were field estimated for all these trees simultaneously with the image acquisition. Conventional Pearson’s correlation and multiple linear regression coefficients were used to check the relationships between tree crown defoliation and radiometric and texture characteristics of orthophoto maps. Then, the defoliation was predicted using the non-parametric k-Nearest Neighbor method and characteristics extracted from the digital orthophoto maps. Prediction accuracies were validated using the field estimated crown defoliation values. The prediction root mean square errors were at the level of around 7-9 percent. Different prediction tactics and image pre-processing such as automatic separation of Sun illuminated and shadow parts of the crowns, principal component or normalized difference vegetation index transformations resulted in changing prediction accuracies. Color-infrared orthophoto maps are discussed as a potential data source to provide forest health characteristics within the frames of stand-wise forest inventories.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Ability of *Tibouchina pulchra* (Cham.) Cogn., a native species from the Atlantic Forest, to tolerate the oxidative stress around an oil refinery in Cubatão, Brazil

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The city of Cubatão, located in the Atlantic Coast, in the southeastern region of Brazil, experienced a rapid industrial development in the 1980's, which brought serious pollution effects on the Atlantic Forest that covers the slopes of the coastal mountains. This impact has been studied intensively by means of biomonitoring programs. *Tibouchina pulchra*, a tree species found in abundance in the region of Cubatão, is known for its tolerance to stress caused by pollutants. Thus, we intended to evaluate the risks posed by pollutants around an oil refinery to the Atlantic Forest, by analyzing the variations in the redox state of this species in response to oxidative stress induced by pollutants before and after the adoption of a new procedure of energy production (thermoelectric power plant). Thus, young plants of *T. pulchra* were exposed in three points situated at different distances of the refinery and in a site less influenced by the industrial emissions. Eight experiments were conducted, covering the period before and after the start of operation of the new power plant. The indicators of redox state analyzed in the plants during the field experiments were: concentrations of ascorbic acid and glutathione and activity of superoxide dismutase, ascorbate peroxidase, glutathione reductase and catalase, as well as stress indicators, as the lipid peroxidation and protein content. The results indicate that the ascorbic acid and glutathione are key antioxidants for the maintenance of tolerance of *T. pulchra* against the oxidative stress caused by air pollution, with preponderance of their reduced forms relative to the total content of these substances. The oxi-reduction responses were intensified in the plants exposed after the start of operation of the new power plant. These facts are indicative of the high ability of *T. pulchra* to tolerate the oxidative stress around the refinery.

Financial support: FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo) 2008/58682-1

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Forest vegetation response to heat and drought stress: The use of MODIS satellite imagery

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This study addresses the intra- and inter-annual variability of forest vigour in the Central Europe during the period 2000–2010 in relation to the incidence of excessive heat and drought events. European beech (*Fagus sylvatica* L.) and several oak species (*Quercus* spp.) are addressed. The analysis has been based on satellite imagery acquired using the MODIS instrument (Moderate Resolution Imaging Spectroradiometer). The main asset of using MODIS products is the global coverage obtained every one to two days; hence such data can be used to describe the intra-seasonal variation in various ecosystems. Normalized Differentiated Vegetation Index (NDVI) with spatial resolution of 250 meters was used to describe the variation in vigour of beech and oak stands. NDVI variations reflect changes in trees photosynthetic activity (although such interpretation should be treated with care), and this can be related to stress (climate-induced or other) acting upon the trees.

Using forest management plans and other environmental databases we identified the clusters of MODIS pixels with monospecific beech or oak composition so as each group contains 5 to 12 pixels. Further, we performed thorough investigation of intra- and inter-annual variations of NDVI values during the 10-year period (2000–2010), and variations in NDVI were interpreted in relation to the incidence of climate extremes. The obtained results contribute to better understanding of forest trees response to climate, and identify critical intensity and duration of the addressed climate extremes, which cause observable stress to beech and oak stands. The obtained results contribute to better understanding of forest trees response to heat and drought stress, and they reveal a new field for using the MODIS satellite imagery in forestry research.

Acknowledgement: This research was supported by project of the Slovak Research and Development Agency „Spatial and ecophysiological aspects of climate impact on forest ecosystems under climate change" under contract No. APVV-0111-10.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Spontaneous recovery of mountain spruce forests after natural disturbances

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Recently, large-scale natural disturbances such as bark beetle outbreaks and windfalls have appeared relatively more frequently in Central-European mountain spruce (*Picea abies* L.) forests, which raised doubts about the possibility of their restoration and led to the enforcement of salvage logging even in some protected areas. Our study was performed as part of a long-term observation of recovery of spruce forests affected by bark beetle and windfall with and without interventions in two Central-European national parks, Šumava National Park in the Czech Republic and Tatra National Park in Slovakia.

Evaluation of natural regeneration showed a positive effect of left dead trees on successful spontaneous recovery of spruce stands after both bark beetle outbreak and windfall. A substantial part of natural regeneration in forests after bark beetle outbreak was formed by spruce, which originated before the disturbance (thousands of seedlings/ha), and rowan being the second most numerous species (hundreds of seedlings/ha). Pioneer species, such as birch (*Betula* sp.), willow (*Salix* sp.) and aspen (*Populus tremula*), appeared mostly on disturbed soil surfaces after windfall. In comparison to natural disturbances, artificial disturbances resulting from interventions against bark beetle and salvage logging after windfalls destroyed a substantial part of the natural regeneration and resulted in several times lower numbers of seedlings in cleared plots, which led to the need for artificial reforestation. The non-intervention approach achieved higher numbers of spruce and rowan than artificial reforestation and at no cost. The height and age structure of spruce regeneration was reduced in cleared plots compared to uncleared plots.

Unlike natural disturbances, the disturbance caused by salvage logging had a significant negative effect also on herb vegetation of mountain spruce forests. Thus, the non-intervention strategy appears to be the best option for restoration of disturbed forests in the zone of mountain spruce forests, which usually form the core zone of national parks. Moreover, the non-intervention approach allows for natural selection, which will lead to the formation of substantially more resistant stands.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Rapid assessment of wind storm caused forest damages using satellite images and stand-wise forest inventory data

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The paper will introduce a method for rapid forest damage assessment using satellite images and stand-wise forest inventory data. Two Landsat 5 TM images from June and September, 2010 and data from stand register, developed within the frames of conventional stand-wise forest inventories in Lithuania were used to assess forest damages caused by wind storm from 08.08.2010. Difference images were developed using calibrated for geometry and radiometry satellite images. Then, the percentage of damage in terms of wind-fallen or broken volume was predicted for each forest compartment inside the zone potentially affected by the wind storm employing non-parametric k-nearest neighbour technique. Satellite imagery based difference images and general forest stand characteristics from the stand register were used as auxiliary data sets for prediction. All auxiliary data were available from existing databases, i.e. did not involve any extra data acquisition costs. Simultaneously, the aerial photography of wind storm damaged area was carried-out to produce CIR orthophotos with ground sampling density of 0.5x0.5 m. Precise manual interpretation of wind storm effects was used to validate satellite image based estimates. Total wind damaged volume in pine prevailing compartments (~1180000 m^3) was underestimated by 2.2%, in spruce prevailing compartments (~233000 m^3) – by 2.6% and in deciduous prevailing compartments (~195000 m^3) – 4.2%. The overall accuracy of identification of wind damaged areas based just on difference images available from two-date satellite images was around 95%.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Declining symptom of mountain birch (*Betula ermanii*) in northern Japan

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Die-back and death of mountain birch (*Betula ermanii*) have been observed in northern Japan. The declining symptom occurs near the hill top where wind is strong and nutrient poor soil is dominant in Hokkaido Island. Therefore, we try to know the reason why mountain birch is declining via monthly monitoring the gas exchange traits of both declining and healthy trees and using open-top chambers for seedlings at the site. Moreover, we surveyed forest soil and vegetation there.

Study sites were located at the somma of Lake Mashu in Northeast Hokkaido. We have been monitoring atmospheric ozone [O_3] with both active and passive sampling methods. We selected each 4 individual trees of around 20 years old of both declining (less than 50% leaves attached to a crown) and healthy ones. Shoots of sunny crown in both trees were obtained and carried them back to the lab. Six OTCs were used with each 3 charcoal filtered and non-filtered to access the effects of [O_3] on plant growth. Photosynthetic characteristics were determined with a LiCor-6400 porometer and other physiological parameters were measured.

Atmospheric [O_3] reached to 80-100 ppb during April to June and was around 50 ppb through the growing season. Soil is originated from immature volcanic ash with shortage in phosphorous. Net photosynthetic rate of declining trees were lower at CO_2 and/or light saturation than that of healthy ones with smaller leaves and lower chlorophyll content. With OTCs, seedlings at non-filtered leaves had smaller allocation of photosynthates to roots and low infection of ectomycorrhiza. Based on results, high [O_3] in spring may damage on some trees with poor root systems. Cumulative [O_3] effects on trees may be a cause of tree declining due to unique leaf phenology of mountain birch.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Impact of alkaline dust pollution on the formation of the crowns of Scots pine and Norway spruce in the industrial region of Estonia.

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The Northeast Estonian industrial region offers a unique opportunity to investigate the response reactions of trees to alkaline solid pollutants and alkalisation of the environment. One of the major producers of industrial alkaline dust pollution in Northeast Estonia is the cement plant in Kunda. The aim of investigation was to assess the influence of the industrial alkalisation on the formation of the crowns of Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* (L.) Karst.). Attention is paid on the analysis of morphological changes in the crowns of Scots pine and Norway spruce growing in forest sample plots. The seven sample plots with 75–90-year-old pine and spruce stands of *Oxalis–Myrtillus* forest site type were selected at different distances and directions from a cement plant influenced over 40 years by alkaline dust pollution. High pH values (6.1–7.8), large concentrations of dominant dust components (Ca, Mg, K) and a lower level of N and organic matter in the upper layers of soil within about 6 km from the emission source compared to the unpolluted control area 30.4 km from the source (pH 3.3) were found. On the most polluted area the height of trees and living crown, the length of shoots and needles were lower, and average life span of needles were shorter than in unpolluted area, indicating an increased defoliation rate of the crown.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Spectral reflectance properties of healthy and damaged coniferous trees

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The aim of the study was to investigate the hyperspectral reflectance properties of needles taken from healthy and damaged coniferous trees. Two coniferous tree species which naturally grow in Lithuania (Scots Pine and Norway Spruce) as well as two introduced coniferous tree species (Mountain Pine and Siberian Pine) were selected for the research. The hyperspectral reflectance data was obtained under laboratory conditions scanning the needles of healthy (0 defoliation class – foliar loss 0-10 %) and damaged (3 defoliation class – foliar loss 61-99 %) trees. Hyperspectral images were acquired using Themis Vision Systems VNIR 400H portable hyperspectral imaging camera to represent spectral properties in the 400-1000 nm range. The content of chlorophyll in the needles was measured as well. Methods of principal component analysis, analysis of variance and partial least squares regression were employed for the obtained data analysis. Strong correlations between the spectral reflectance properties of coniferous trees and their health condition were observed and spectral bands (wavelengths) which describe the spectral differences between healthy and damaged trees best were determined. In general, the study revealed that narrow band based hyperspectral imaging has a good potential for detecting the stress of coniferous trees within the frames of remote health monitoring using airborne hyperspectral sensor.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Assessment of sanitary condition in bud scale *Physokarmes piceae* Schrnk. damaged Norway spruce *Picea abies* (L.) Karst. Stands

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Bud scale insects affect spruce in two ways – directly and indirectly. Direct injury by damaging tissues using moth parts and sucking sap from phloem. Indirect injury by honeydew secretion. Plant sap consist mixture of carbohydrates called photosynthate that is hard to digest for scale insects so it is secreted with excrements, which are used by such fungus as black sooty mold. It covers needles, blocking stomata what causes decrease of transpiration and photosynthesis. Already in 2010 in Latvia was registered inexplicable wither of Norway spruce. However there were no signs of bud scale presence. But in 2011 was found mass propagation of these scale insects. In research of Latvian State Forest Research Institute „Silava" was found that bud scale mainly concentrate on third topmost of tree. So objective of this research is to establish if Kraft class has some influence on level of tree foliage damage. Objects of research are six second old class Norway spruce stands. Data were collected in circular sample plots with radius 7.98 m, on one ha were made 2 plots, in which were measured all tree diameters on height 1.3 m, also about 30 tree height for modelling contour line. For all trees were determined Kraft class and level of foliage damage caused by bud scale and black sooty mold. Foliage damage was defined in five levels (0 – healthy tree, 1 – quantity of needles decreased about one third, 2 – quantity of needles decreased about two thirds, 3 – all needles are yellow, 4 – tree has been withered in current year). Highest percentage (21 %) of damage was found on second Kraft class trees with first damage level. Also 10 % of fifth Kraft class trees have the highest damage level (4). Damage intensity overall is 29.3 %.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Foliar symptoms specific for ozone stress in rain forest trees of southern Brazil

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Toxic effects of tropospheric ozone concentrations on the natural vegetation have been primarily reported for ecosystems from the northern hemisphere with a mediterranean, temperate or boreal climate. In the southern hemisphere and tropical ecosystems, the impact of ozone is still unknown. This ongoing study has a principal objective of investigating the effects of current ozone concentrations in three tree species (*Astronium graveolens*, Anacardiaceae; *Croton floribundus*, Euphorbiaceae; *Piptadenia gonoacantha*, Fabaceae) from the tropical, moist Atlantic Forest (*Mata Atlantica*) in Brazil. Year old seedlings were exposed to O_3-enriched air using indoor chambers (70 ppb/h during 57 days). During fumigation, the foliar injury, percentage of symptomatic leaf area and defoliation were regularly assessed. The microscopic symptoms have been analyzed in light and electron microscopy. In *A. graveolens*, visible injury increased linearly with ozone exposure. Symptoms were caused by reactions in apoplast in the form of massive wart-like cell wall thickenings and subsequent oxidation. Leaflets of the composite *P. gonoachanta* leaves quickly developed stippling and chlorosis prior to shedding within the first 10 days of exposure. Stippling was underlain by symptoms resulting from HR-like plant responses within restricted groups of upper palisade parenchyma cells. Besides accelerated leaf senescence, no visible or microscopic symptoms were observed in *C. floribundus* suggesting that this species is rather tolerant to O_3. Hence, contrasting reactions were observed in the three analyzed species suggesting a large variability of ozone sensitivity in relation to the high biodiversity to be found in the *Mata Atlantica*. Microscopic symptoms matched those described in species from the northern hemisphere only partially and were most distinct in the Anacardiaceae, a still little investigated species. Using these findings, ozone symptom monitoring in the field and further fumigation experiments are under way.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Estimating crown defoliation of Scots pine (*Pinus sylvestris L.*) trees using small format digital aerial images

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This study compares the opportunities of small format digital aerial images and the images captured using large format digital frame aerial camera to estimate Scots pine (*Pinus sylvestris L.*) crown defoliation. Test area in the eastern part of Lithuania was photographed using Canon EOS-1DsMark II digital camera, installed on-board SkyArrow ultra-light aircraft. Camera lenses were adopted to capture images corresponding to the conventional color-infrared photography. Simultaneously, the test area was photographed using large format digital frame aerial camera Vexcel UltraCam D, installed on-board Rockwell Turbo Commander 690A, a high performance commuter aircraft. Ground sampling density of the achieved images was around 10 cm. Crown defoliation was assessed in the field for more than 500 Scots pine trees located on 46 sample plots in 4 forest compartments, aged between 65 and 170 with similar other dendrometric characteristics. Conventional Pearson's correlation and multiple linear regression coefficients were used to check the relationships between tree crown defoliation and characteristics of images. Then, the defoliation was predicted using the non-parametric k-Nearest Neighbor method and data available just from aerial images and compared with the true, ground estimated defoliation values. The prediction root mean square errors achieved using small format aerial images for younger trees were at a level of around 11.5 percent, using conventional aerial images – at the level of around 9.5-9.9 percent. The differences in prediction root mean square errors practically disappeared on older stands – achieved root mean square errors were at the level of 8.1-8.5 percent. Defoliation class was correctly predicted for approximately 84-88% of older and 75-85% of younger tree crowns. General conclusion of the study was that the small format aerial images contained the potential to predict defoliation at tree crown level compatible with the conventional aerial images being several times cheaper when the areas targeted were relatively small.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Impact of human activity on variability of the unique population of silver fir (*Abies alba* Mill.) from Tisovik Reserve (Belarus) expressed in microsatellite chloroplast DNA polymorphism

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Population from Tisovik Reserve is a small, isolated and natural stand of European silver fir located the farthest, i.e. 120 km north of the natural range limit of this species in Bialowieza Primeval Forest. It is a native and relict population and fir has been growing uninterruptedly for 300 years at this stand. In 1921, when Tisovik belong to Poland, the Reserve was created. It existed until World War II. After the war, the Tisovik Reserve became part of Belarus. Drainage of the Dikij Nikor bogs and pasturing of cattle and sheep began at that time and aggravated environmental conditions caused severe losses in the silver fir stand. In these time the number of silver fir sharply decreased from several hundred firs in 1887 to 20 in 1995. Recently the number of silver fir trees in the population has reached a critical level and silver fir may completely disappear. In 1991 the Tisovik Reserve was incorporated into the Belarusan National Park, and the silver fir of Tisovik was registered as a species threatened with extinction. Because of that, the preservation of its gene resources is urgent. So, this investigation is aimed at describing the genetic structure of silver fir progeny from 19 the last maternal trees and comparison to its parent on the basis of 4 *loci* of cpDNA. Molecular analysis of variance (*AMOVA*) showed that these progeny differ statistically significantly from one another and that 5% total detected variation is found between progeny, while 95% within progeny. Analyses showed that all examined *loci* were polymorphic. The number of alleles per *locus* ranged from 2 to 8. Gene flow between the progeny was high and amounted to 9.953. The highest value of the genetic variation coefficient was found for line T1, while the lowest for line T4. These investigations showed that the level of genetic variation in the progeny of firs from Tisovik is low in comparison to its parent and other populations of this species.

The study has been financed from budget funds allocated to science in the years 2010 – 2013 as research project no. N N305 373938.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Microscopic symptoms and antioxidant responses as integrated measurements of tolerance to air pollutants in a native species to the Atlantic Forest, Brazil

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The air pollutants emitted from petrochemical industries such as sulphur oxides, nitrogen oxides and particulate matter are damaging the Atlantic Forest that covers the slopes of the coastal mountains, in the Cubatão city – southeast Brazil. *Tibouchina pulchra* (Cham.) Cogn., a pioneer tree species commonly found in this region, has been used as a biomonitor due to its high tolerance to air pollutants. Therefore, this study aims to verify whether the combined analyses of intensification of antioxidant in response to oscillations in environmental stress factors and of disorders caused by pollutants at microscopic level, in both young and adult trees is an adequate measurement of tolerance to air pollutants of such species. The experiments have being conducted in five sites at different distances from the main petrochemical industry three on the slopes of the mountains at different altitudes one in the Cubatão downtown and one less influenced by the industrial emissions. The young plants are exposed in each site for consecutive periods of 84 days. The leaf samples have being collected at zero, 42 and 84 days of each exposure experiment. In addition, leaves of six adult trees per site were sampled for the passive biomonitoring. The leaves were fixed and processed according usual techniques for analyses of microscopic injury caused by oxidative stress and indicators of the redox state. Preliminary results indicate that both young and adult trees near the industry present increased concentration of ascorbic acid, decreased concentration of glutathione in both forms, increased lipid peroxidation. They do not accumulate hydrogen peroxide, but phenolic compounds condensed tannins are clearly accumulated in the mesophyll cells, abaxial epidermal cells and subsidiaries cells. These integrated measurements seem to indicate that the species tends to increase its tolerance to oxidative stress by investing on the secondary metabolism.

Financial support: FAPESP (Fundação de Amparo à Pesquisa ao Estado de São Paulo) - Processo 2011/11102-3

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Soil respiration measurement in five different forest types in Serbia

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In the frame of the project entitled III 43002 “Biosensing Technologies and Global System for Long-Term Research and Integrated Management of Ecosystems” funded by Ministry of education and science of Republic of Serbia, five different forest ecosystems were selected to start continuous monitoring of health condition, soil conditions and ecophysiology related to the impact of environmental pollution and climate change. In selected sites a grid for measurement of soil respiration with 25 points was set in May 2011. At each site, 10 randomly selected points was selected for 6 week interval measurement of soli respiration and evaporation with portable gas exchange system from mid-May until mid-September. Soil respiration measurement was performed in following forest associations: (I) alpine beech, (II) sessile oak-beech, (III) spruce; (IV) douglas fir-spruce plantation and (V) silver fir-spruce-beech. Measurements were performed in the morning from 9 to 12 hours, and in the same time, samples of soils were taken to determine soil moisture at depths of 10, 30 and 50 cm. Soil respiration varied from 0.554 $\mu molCO_2m^{-2}s^{-1}$ for spruce stand in May to 4,239 $\mu molCO_2m^{-2}s^{-1}$ for silver fir-spruce-beech stand in August. Evaporation ranged from 0.0257 $\mu molH_2Om^{-2}s^{-1}$ for spruce in June to 0.0777 $\mu molH_2Om^{-2}s^{-1}$for sessile oak-beech in September. The results showed spatial and temporal variation amongst investigated sites and necesity for further research.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Reaction of Scots pine crown condition to changes in air pollutants, acid deposition and meteorological parameters: cae studies in Lithuanian National parks

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The Monitoring net of forest ecosystems in the least polluted areas of Lithuania was established during 1989-1992. The main aim of the study was to determine and predict the condition of Pine stands and their changes with respect to the regional variation of pollutant load and meteorology. Data on pine crown condition collected in Aukštaitija, Zemaitija and Curonian Spit National Parks for almost 20 years allowed analysing key factors responsible for changes in forest conditions on a regional scale in Lithuania. Our earlier investigation revealed that defoliation of Scots pine (*Pinus sylvestris* L.) is closely related to air concentrations and wet deposition of acidifying compounds. In the present study we would like to check the hypothesis that meteorological parameters could reduce negative effect of acidifying compounds and improve pine condition under the rapid climate change condition. The obtained results revealed that spring and summer precipitation and mean winter temperature were shown to be the key factors affecting defoliation. High wind speed also deteriorated pine crown condition. Recent warmer winter and autumn seasons, increasing humidity of vegetation and decreasing wind speed over the dormant period should increase tolerance of pine trees to phytotocic affects of air pollutants including surface ozone and acid deposition in north-eastern part of Lithuania in the near future.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Relationships between leaf area index and remotely sensed data

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The leaf area index (LAI) is one of the most important structural characteristics of the forest ecosystem and forest productivity. There are numerous solutions to assess the LAI using indirect field estimation methods, however they are still rather expensive and time consuming procedure, resulting in a spatially incomplete sampling. Remote sensing has proven to be operational solution to replace or support the LAI field estimations within the frames of forest monitoring programs. The LAI field estimates using the HemiView system, Canopy Analysis System SS1 SunScan and SUNFLECK PAR Septometer SF-80 sensors on permanent field plots with crown transparency, volume of trees, biodiversity and abundance of ground vegetation data available were compared with the characteristics extracted from remotely sensed images. Airborne color-infrared digital aerial images with the spatial resolution of 10 and 50 cm and Landsat TM spatial images were tested in this study. Multiple regression methods were used to develop relationships between the field and imagery data, such as normalized difference vegetation indices, texture characteristics, within varying search windows. Relationships between the LAI, estimated using different techniques and the parameters available from remotely sensed images indicated great potential of use first of all of digital aerial photography for forest productivity and health assessment. The use of archive remotely sensed images for the retrospective LAI assessment was also analyzed in the study.

Session 3: Forest Health, Methods and Tools for Forest Monitoring

Spatial distribution of lichen communities along a potential pollution gradient in a coal mining region of South West Western Australia

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During the last few decades, various techniques for using lichens as biomonitors have been developed for monitoring air pollution and forest ecosystem health. Literature confirms that lichen diversity and density can be effectively used to determine the dispersion of pollutants, however the approach has not been used in Australia. This study investigated the distribution of lichen populations along a potential pollution gradient from coal-fired power plants, in native Jarrah forests of Collie, South West Western Australia. Questions addressed were: (1) Which site characteristics play a key role in the distribution of lichen communities and abundance in the Jarrah forests surrounding Collie? (2) Do forest management practices play an important role in the distribution of lichen communities and their abundance? (3) Are industrial pollutants controlling the distribution of lichen species richness and abundance along the potential pollution gradient?

Our study found a total of twenty lichen taxa in thirty six sites, with the highest number of species and lichen cover observed in control sites. A positive correlation was observed between distance to coal-fired power plants and lichen abundance data, indicating a higher lichen density away from these pollution point sources. A principal component analysis was performed and the ordination plot showed distinct differences in lichen communities along the pollution gradient. No correlations were observed between forest characteristics such as fragment size, stand density, canopy cover, fire history, harvesting history and lichen diversity or abundance data. A significant correlation was observed between log density and lichen abundance data. These results confirm the use of lichens community structure as a cost-effective tool for monitoring the impacts of pollutants in native forests of South West Western Australia.

Session 6 “Multiple Stressor Effects on Ecosystems”

The dendrometrical characteristics of snow-inclined young growths of birch

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The extreme high amount of snow cover in winter of 2011 has caused significant damages in forests of Latvia. There were more than 420 000 m^3 of wood destroyed in state forests. The most part of snow-inclined stands are determined for the decay and are planned to be cut and the area - reforested. Because of the thick cover of snow and of the impact of ice the birch trees are irreversibly inclined. At the end of December of 2010 the intensive rain event was followed by frost and trees were covered in ice. At the beginning of January of 2011, due the interaction between the snow and rain, there was a weight of several hundred or even several thousand kilograms hanging on a tree canopy. In numerous birch stands with the tree height of 8-10 m, there were about 70-80% of trees considerably inclined to the ground.

The scientifically and practically important is the further development of the damaged stands and individual trees. To research this question in summer of 2011 there were several sample plots established in birch stands in different regions of Latvia. The dendrometrical characteristics of trees, i.e. height, diameter, length and the width of the canopy were measured. To find out the limits of the viability of trees, the radius of the inclination of each damaged tree was estimated.

Session 6 "Multiple Stressor Effects on Ecosystems"

First results of growth characteristics of hybrid aspen, birch and grey alder fertilized plantation on former farmland

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Aim of experiment to examine potential of promotion of growth of fast growing deciduous trees by fertilization or management. Wood ash (6 t ha^{-1}), digestate – biogass production residual (30 L ha^{-1}) and municipal waste water treatment plant sediments – sludge (10 t_{DM} ha^{-1}) were used as fertilizers. Silver birch seedlings, two clones (4; 28) of hybrid aspen plants, grey alder seedlings, and four clones of poplar (ALASIA F2; F6; F8; F7) have been planted under maximal allowed due to ecological reasons or recommended doses of nutrients in fertilizers.

Annual increment of trees had been measured and calculated proportionally of increment to "planted tree height". Results shows that most significant effect to growth of tree species shows organic fertilizers. At species of trees level most significant effect had clones, no fertilizer.

Research work are supported by European Development Fund project "Elaboration of models for establishment and management of multifunctional plantations of short rotation energy crops and deciduous trees" Nº 2010/0268/2DP/2.1.1.1.0/10/APIA/VIAA/118

Session 6 “Multiple Stressor Effects on Ecosystems”

Effects of contrasting weather conditions on leaf biochemical and physiological traits of canopy tree species in a mixed oak forest

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In this study we investigated some leaf physiological and biochemical traits of mature sessile oak (*Quercus petraea* (Matt) Liebl.) and turkey oak trees (*Quercus cerris* L.) in two consecutive growing seasons (2009, 2010) differing in weather conditions at the Síkfőkút LTER forest site, Hungary. Total rainfall and mean air temperature in the vegetation period (DOY 91-304) were 299 mm and 17.9 ^{o}C and 671mm 16 ^{o}C in 2009 and 2010, respectively. De- Martonne aridity index (I_{DM}) reflected arid and semi-arid range conditions in 2009 and humid and slightly arid conditions in 2010. After bud break leaf CHL a+b content (per unit of dry mass) was low, but later rapidly increased during leaf expansion with simultaneous increase of LMA in both canopy layers of oak species and reached the values characteristic of mature leaves by DOY 160. In contrast leaf carotenoid content per CHL a+b (CAR) was the largest at the start of leaf expansion with higher values in the upper canopy of trees. Leaf proline (Pro) content was also the highest in spring. CAR and Pro decreased till DOY 140-160 and their summer values depended on the canopy poison and the onset of drought or heat stress. Higher leaf carotenoid and xanthophyll cycle (VAZ) pigment content was found in upper canopy position. VAZ pool reached larger values in leaves of turkey oak. Summer drought in 2009 resulted 20 % increase in VAZ compared to 2010. Spring drought in 2009 resulted in smaller F_v/F_o in leaves of earlier flushing sessile oak compared to 2010 which indicated strong photoinhibition. The study was performed with the support of OTKA No.68397 and Life08 ENV/IT/000399.

Session 6 “Multiple Stressor Effects on Ecosystems”

Water freezing in Siberian spruce needles and buds

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The ability of tree species in the North to adapt to below 0 °C temperatures during the cold year season is genetically pre-determined. There are two mechanisms of tree tissue survive freezing temperatures: freezing avoidance and freezing tolerance. The Siberian spruce (*Picea obovata* L.) is characterized by freezing tolerance. In spruce tissues cellular water is transformed to extra-cellular ice. Sudden frost may injure spruce needles during the vegetation period due to the loss of frost resistance. Climate change and pollution of environment can increase the level of damage spruce needles due to worsening tree health and/or displacement of plant development phases. Temperatures of ice formation in the Siberian spruce needles and vegetative buds were studied by the differential scanning calorimetry (DSC-60 Shimadzu, Japan). The study area was located in bilberry spruce stand of middle taiga subzone in the Lyaly Forest-Ecological Station of the Institute of Biology (62°17′ N latitude, 50°40′ E longitude). Sample of bud or needle was placed in calorimeter weighing bottle and freezing from +5 °C to -30 °C with 1°C per minute. The freezing point of water in buds of Siberian spruce (-14…-17 °C) was lower than that in needles (-10…-16 °C) for during year. In winter extra-cellular ice formation did not injure the spruce buds and needles. Damage and loss of needles and buds of spruce after sudden frost during growth period was observed before ice formation. In experimental conditions the death of spruce needles and buds was occured after water crystallization during the growth period.

Session 7: "Environmental Quality and Pressures Assessment under Global Changes"

Quantitative and qualitative assessment of changes in main geosystems components of rivulet catchments at Lithuanian IM stations

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Integrated monitoring proramme of relatively natural forest ecosystems started in Lithuania in 1993-94. The obtained data allowed for evaluating the effect of changes in long range transboundary air pollution, atmospheric deposition and climatic conditions on the dynamics of the main components of geosystems: soil, soil water, ground water regime and their chemical compositions were evaluated. Average soil temperature in 1999-2011 was stable, meanwhile in January showed a tendency towards increasing by 0.25 ºC per year and in July - towards decreasing at an average by 0.45 ºC per year. These changes were most significant from 2001 through 2008. In 2010 average soil temperature began to increase even during warm season of the year. Increase of temperature in cold and decrease in warm seasons occured along with changes in humidity regime.

During 2004-2010 concentrations of potential pollutants (sulphur, nitrogen and heavy metals) in run off water increased indicating the wash out of these contaminants from the soil. As a result of that soil became less polluted by these considered pollutants than over the period 1995-2003, followed by pH increase in soil as well as in ground and stream water. Changes in climatic condition supported these positive processes in forest ecosystem.

Session 7: "Environmental Quality and Pressures Assessment under Global Changes"

A metadatabase comparison from various European Research Networks

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The large amounts of data already obtained within existing monitoring programmes and large-scale international projects can be used to **increase understanding of** the state and potential of natural ecosystems mitigation and adaptation to climate change in a polluted environment, and a major challenge now is to evaluate and integrate the presently available databases. The main goal of the metadatabase, elaborated in the frame of the COST FP0903 Action Short Term Scientyfic Mission, is to integrate the information about the research and measured variables of selected European Research Networks, based on ecosystem types, research subjects and ecosystem levels. All of the selected projects are strongly related to the problem of climate change and its influence on natural ecosystems. It should be emphasised that the metadatabase is not intended to replace existing databases, but to act as an aid to those seeking to find out what information is available in these databases and thus assist in improving access to, and coordination between, the different datasets. Depending on the selected research network, the list of variables included in the database and the measurement units differ widely. As a result, activities related to the identification, evaluation and integration of the presently available databases are most important for the scientific community. Furthermore, and equally important, the recognition of the current knowledge gaps and emerging research areas will be made easier. By unification of the applied methodology, upscaling and comparison of the results will be possible. The presented metadatabase is a first step in this direction.

Session 7: “Environmental Quality and Pressures Assessment under Global Changes”

Crosswalk between EnvEurope (EML) and INSPIRE (EN ISO) metadata profiles – a step towards SEIS

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The EnvEurope project proposes a design for environmental high quality monitoring and long-term research sites and the exemplary establishment of common parameter sets to be collected across the largest site-based network of the Long-Term Ecosystem Research (LTER) in Europe.

The aim of the EnvEurope data management working group is to provide a framework which will allow to share the data within the project and to provide use case for whole LTER Europe network and for SEIS. One step of data sharing paradigm is data discovery and evaluation by its description - metadata. Therefore the EnvEurope community metadata profile for the dataset level has been developed based on EML (Ecological Metadata Language) specification. EML is based on prior work done by Ecological society in United States (US) and has been developed by and for ecologic discipline. It is mainly used within ILTER sites. Since the EnvEurope is European project an INSPIRE form of this community metadata profile had to be taken into account to be developed in order to step also towards a SEIS. For this reasons a metadata crosswalk between EnvEurope and INSPIRE metadata based on EN/ISO19115 standard has been developed and provide initial transformation between those two metadata specifications. Moreover not only metadata elements required by INSPIRE were taken in a crosswalk project.

The EnvEurope metadata profile for dataset level implementation aims at the one hand to support a framework, where interoperable way of long term ecological data exchange across Europe and even more abroad should be achieved. On the other hand it provides useful information to be processed within legislation driven initiatives within Europe as INSPIRE, SEIS and GMES that are planned to be mutually supportive.

Session 7: "Environmental Quality and Pressures Assessment under Global Changes"

Global Change and mast seeding of European tree species. The *EUROMASTING* project

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Mast seeding - the highly variable seed production among years - is very common in tree species, but there is no consensus about its main causes and the extent to which the altered environmental conditions could affect it. The increasing aridity predicted by global change models may negatively affect seed production in dominant tree species by reducing the size of the annual seed crop and/or likely by disrupting the environmental cues that synchronize plants for masting. However, the impact of increasing drought on initial stages of regeneration such as flowering and seeding remains largely unexplored in tree species, particularly of European forest systems. In this study, we are interested in analysing long-term data set on reproductive and vegetative growth of European tree species (mainly *Quercus* spp. and other widespread tree species) along a wide gradient of environmental conditions with the aim to solve the following objectives: i) to describe temporal changes in tree seed production across Europe using long-term data from LTER sites; ii) to identify which environmental factors or resources better explain the interannual variation in seed production (i.e., mast seeding); iii) to test the adaptive (the "resource matching") *vs.* the nonadaptive (the "economy-of-scale") hypotheses for masting for each of the selected sites; iv) to evaluate the magnitude of variation in seed production among sites as a function of their resource availability; and v) to detect recent changes in tree seed production that could be related with global change drivers (climate change, land use change, air pollution). Under a global change scenario, it would be expected that the drier conditions reinforce the negative effects of summer drought on seed production, especially in the most resource-limited ecosystems, leading to negative consequences for tree recruitment and forest dynamics.

Session 7: “Environmental Quality and Pressures Assessment under Global Changes”

Intensive monitoring of forest ecosystems in Serbia

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The intensive monitoring in Serbia is carried out on the plots that are located in the dominant forest ecosystems to study the cases and consequential relationships of anthropogenic and natural factors that cause damage to forest ecosystems. The main objective of intensive monitoring is to obtain better insight into the effects of air pollution and other stress factors on forest ecosystems. The intensive monitoring in Serbia was initiated in 2009 on the Fruška Gora Mt. The sample plot at Fruška Gora is situated in association with the dominant sessile oak (*Quercus petrea*), and there are also large-leaved European linden (*Tilia grandifolia*) and beech (*Fagus sylvatica*) trees present. Second intensive monitoring plot was established at locality Odzaci in 2010 with penduculate oak as dominant species. On both plots, following factors were monitored: conditions of tree crowns, chemical compositions of tree leaves, tree growth rates, phenology, chemical composition of deposition, chemical composition of litterfall, soil chemical composition, leaf ozone damage, ground vegetation and meteorogical parameters. The results showed variation in investigated parameters and necessity to continue with already conducted activities.

Session 7: "Environmental Quality and Pressures Assessment under Global Changes"

Black carbon in the atmosphere and consequences for the global climate; site-based measurements at IM Observatory Kosetice

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Black carbon (BC) is produced by incomplete combustion of fossil fuels by transport, heating, power plants, wood and biomass burning and agriculture activities. BC is a strongly light-absorbing carbonaceous aerosol. Because of its light absorbing properties, BC contributes significantly to global warming by directly absorbing sunlight and to regional warming by darkening ice and snow. Due to the fine size and chemical composition of BC, its negative health effects are also widely recognized. Many terms are used to describe the strongly light absorbing subset of particulate (soot, elemental carbon, refractive carbon, black carbon), but there is no universal definition of identifying which subset of aerosol particles are of concern when addressing climate change. For the purposes of this study, black carbon is synonymous with elemental carbon. Different measurement techniques are used. Within ACTRIS/EUSAAR protocol, collection on filters in fraction $PM_{2,5}$ using denuder or semi-continuous carbon aerosol analyser are acceptable. For the climate related issues, aethalometer is the most common instrument. Regular BC-OC measurement has been implementing at Košetice Observatory since February 2009 within the framework of EU-projects EUSAAR and ACTRIS. Sampling frequency is every 6th day in fraction $PM_{2,5}$ on 2 quartz-fibre filters. The analytical method is thermal-optical analysis. The mean annual concentration of total carbon (TC) in $PM_{2,5}$ was 3,73 $\mu g.m^{-3}$. The figure for BC (0,51 $\mu g.m^{-3}$) represents the mean annual ratio of 14% on TC. BC-OC concentrations follow an annual course that reflects their emission levels, i.e. with maximums in winter and minimums in summer. The seasonal variation of BC/TC ratio is not significant and ranges between 12 to 15%. Mean TC ratio on $PM_{2,5}$ total mass in the period under review was 26%. BC participated on $PM_{2,5}$ total mass by 4% in average. 3D trajectories were used for sector analysis of measured BC-OC data. The highest concentrations are recorded in situations when air masses reach the territory of the Czech Republic from the eastern directions or the local air masses prevailing.

Session 7: “Environmental Quality and Pressures Assessment under Global Changes”

Long-term monitoring of methane in the atmosphere at Kosetice Observatory

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Methane contributes about 20% of the direct radiative forcing due to long-lived greenhouse gases affected by human activities. Its chemistry also indirectly affects climate by influencing tropospheric ozone. Sources of methane are both natural (40%) and anthropogenic (60%), and include natural wetlands, rice paddies, enteric fermentation, gas drilling and biomass burning. Methane is removed from the atmosphere by reaction with hydroxyl radical (OH) and has an atmospheric lifetime approximately 9 years. The concentration of methane was about 700 ppb in pre-industrial age (before the 18^{th} century). The increasing emissions from anthropogenic sources are responsible for the factor 2,5 increase globally. The results from the global network of Global Atmosphere Watch programme indicate the continuous growth of methane concentrations in global scale in the period 1984–2009. The concentrations are higher in northern mid and high latitudes and low in the Southern hemisphere. The latitudinal distribution suggests main sources of methane in mid and high latitudes of Northern hemisphere. The amplitude of seasonal cycle is more significant in the Northern hemisphere. Methane measurements were started at Košetice observatory in 1995 under the GAW programme. The sampling is implemented at 12.00 o´clock UTC every Monday and Thursday for the duration of 10 minutes. Methane is quantified by gas chromatography in a capillary column with a flame-ionisation detector. The mean annual concentration in the period 1996–2011 at Košetice observatory was 1887 ppb. The nonparametric Mann-Kendall method was used for statistical evaluation of VOCs trends significance. Statistically very significant upward trend was found in the period under review. Mean annual increase was 12 ppb/year. The results are comparable with the GAW stations of mid-latitudes of the northern hemisphere.

The requirements: Session 8: Genetic Aspects

Genetic diversity of black pine (*Pinus nigra* Arn.) population tolerant to heavy-metal pollution- microsatellite DNA analysis.

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Chloroplast microsatellites (cpSSR) have been widely used in population genetic studies of conifers in recent years. The application of these markers makes it possible also to assess genetic variation of populations growing under strong stress conditions. Black pine is one of the most tolerant conifer species to environemental pollution. The main aim of this study was to examine genetic diversity of black pine using chloroplast microsatellites markers. Analyses were conducted on natural regeneration of black pine stand growing within the protection zone of the Zinc Smelter in Miasteczko Śląskie (S Poland). Two groups were observed among examined specimens. The first (R-resistant) was characterized by a markedly better health condition of trees included in this class, while the other group comprised trees exhibiting high sensitivity to pollution (S-sensitive). Between these two groups of specimens high differences in genetic structure were observed.

These results in combination with observations concerning the overall condition of examined trees may indicate the action of selection pressure directed against specific alleles. This study also demonstrates that cpSSR markers could be a useful complementary tool to isoenzyme markers in explaining the pattern of genetic differentiation of heavy metal-resistant and sensitive populations.

This study was financially supported by Polish NCN grant no. NN 305058440 „Comparison of micro- evolutional processes taking place in the two bioindicative species; Pinus nigra Arn. and Pinus sylvestris L. grooving in a heavy polluted environment.

Session 8: Genetic Aspects

An approach to study the genetic tolerance to industrial pollution in Scots pine

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An approach to study the genetic tolerance to industrial pollution is presented. A clonal seed orchard of Scots pine located in the vicinity of a nitrogen fertilizer plant is selected as the initial material for the study. The orchard was established in 1969-74 and had experienced a pollution stress after large-scale emissions caused by a major accident in the fertilizer plant in 1984. The aims are to (a) assess the present-day genetic variation and heritability of the defoliation, health status and survival of the clones, (b) assess the genetic variation and heritability of annual radial increment during the each year starting interactions from the earliest available rings and focus the attention on the strength of genetic control and the G x E of radial increment during the periods of high pollution emissions, (c) assess the genetic variation and control of other traits of the orchard clones related with the pollution tolerance: primarily needle anatomy traits such as stomata number per unit area, stomata row number, cuticle thickness, number of vascular tracts (d) correlate the annual radial increments during the pollution stress with the present-day variables (needle anatomy traits, defoliation, survive), (f) based on the above given tests, identify a number of presumably tolerant and susceptible clones; collect seed and establish a climate chamber test to verify the tolerance, (g) select a number of individuals with contrasting tolerance values and perform DNR marker study to reveal sequence polymorphism at the expressed sequences within genes connected to pollution stress such (e.g. stomata physiology, photosensory domains (PHYP, PHYO).

Session 8: Genetic Aspects

Indirect evidence of genetic tolerance to industrial pollution in Scots pine

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Aim of the study was to assess the genetic variation in tolerance to industrial pollution of Scots pine clones in a seed orchard located in vicinity to Jonava (JV) fertilizer plant. The annual radial increment and its genetic component in response to the variable levels of harmful emissions in 1981 to 2010 were used as estimates of the pollution tolerance. The seed orchard consists of 28 clones with 20 ramets each and was established in 1970-74 with the local genetic material. In 2011, increment cores were sampled, tree diameter, defoliation score, cone yield and phenology of the seed orchard clones were assessed and annual radial increment was identified and verified as reliable starting at 1981. From the represent-day variables, the highest broad sense heritability (H^2) was obtained for defoliation score (0,17) followed by tree diameter (0,14). For the annual radial increment, the H^2 values varied between 0 to 0,16 and peaked periodically approximately each fourth year with the following interpretable connections: (a) in 1990 (the year preceding the major accident in JV plant in 1989), the H^2 peaked simultaneously with the radial increment; at the same time, the genetic correlation between defoliation in 2010 and radial increment in 1990 increased to -0,5 (significant), (b) during 1992-1995 when the highest defoliation the surrounding stands was recorded, the H^2 increased markedly; as in the case above, the genetic correlations between defoliation in 2010 and annual radial increments of 1993, 1994, 1995 turned to highly significant (– 0,6). Similar patters as with H^2 were reflected by CVa. The corresponding genetic correlations with the diameter 2010 also increased during the 1993-1994 stage. In conclusion, our study showed that the variation in strength of genetic control of annual radial increment of Scots pine clones affected by industrial pollution may not be random and there are associations with high defoliation levels especially for years 1992 – 1995. There was a weak tendency for a stronger genetic control in the years with higher increments. The clones representing the extremes for high and low radial increments during the stress period of 1992-1995 were selected for further tolerance testing based on needle anatomy traits.

The request: Session 8: Genetic Aspects

Growth responses of silver birch (*Betula pendula* Roth) to environmental change

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Silver birch (*Betula pendula* Roth) is one of the most important broadleaved species in Europe. In Poland, birch (*B. pendula* Roth and *B. pubescens* Ehrh.) covers 7,4% of the total forest area (9,1 million ha) and constitutes 4,6% of the total growing stock.

The aim of investigations was to estimate provenance and family variation of Polish and Latvian birch in flushing and growth in 3 plots. Flushing were scored using 6 point scale during 2 springs. Analysis showed significant differences between provenances both in sites and years. Investigation of the flushing showed that provenance ranking of flushing does not depend on the observation's year. Latvian provenances and 2 provenances from the N-E part of Poland (Augustów, Browsk) flush early. There is strong genetic effect on flushing. Longitude had important influence on flushing – more eastern provenances tending to flush earlier. Family heritability was moderate high: 0,79 – 0,86 and individual was the lowest: 0,49 – 0,70.

Provenances from the N-E part of Poland were the most flexible and had the best growth in each localization. The most number of families with positive index were also in Augustów and Browsk. The family heritability for height ranges from 0,28 to 0,83. Regression models were used to express survival, growth and flushing of European birch provenances in relation to climate variables between provenance and common garden locations. The summarized result showed that growth and survival traits exhibit a variation patterns and have a large potential for adaptation to changing climate. The analyses utilized the set of global climate data available at WordClim.org.

Session 9: "Hydroecology"

From dry cleaning to dirt – trichloroacetic acid in forests

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It is 25 years since chlorinated solvents were implicated as contributors to 'Forest decline' in Europe. Advances in analytical techniques permitted the detection and quantification of solvents and their assumed breakdown products in plant tissue and soil. Trichloroacetic acid (TCA), a known herbicide, was suggested as a major oxidation product of chlorinated solvents in the atmosphere, and was found ubiquitously in vegetation, soil and waters. Over many years, detailed experiments in the laboratory and in the field studied the pathways of TCA through plants/soil/water and established that TCA was present in many environmental compartments, and was removed effectively, implying biological processing. Direct evidence of damage to trees, at concentrations present in the environment, was not conclusive. Further investigation showed that substances that gave an apparent 'TCA' signal in chemical analyses could be produced in soil by fungi, and that much of what had been identified as 'TCA' could have arisen from more complex macromolecules formed naturally in soil. This paper traces the history of TCA and forests over the past 25 years, and illustrates the various stages of discovery leading to our present-day understanding – including public, industrial and scientific perspectives.

Session 9: Hydroecology

Atmospheric deposition and stream water chemistry in a dry evergreen forest in northeast Thailand

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The Acid Deposition Monitoring Network in East Asia (EANET) has promoted case studies on catchment-scale analysis in several forest types of the East Asian region, including tropical forests. A small catchment plot was established in a dry-evergreen forest in the Sakaerat Silvicultural Research Station, Nakhon Ratchasima Province, Thailand. The climate was classified as tropical savannah (Aw), which had distinct wet and dry seasons. Throughfall (TF), stemflow (SF) and stream water (SW) have been collected twice a month in the catchment plot since 2005. Soil chemical properties and ion fluxes in soil layers were also determined intensively. Deposition amounts of all ions by TF+SF significantly increased in March/April and September/October, in the beginning of wet season and late wet season, respectively. It was suggested that gaseous and particulate matters were washed out by the first precipitations in the beginning of wet season, while the large deposition in the late wet season could be attributed to higher precipitation in this period. From early to middle wet seasons, specific phenomena were seen in the SW chemistry. The pH and EC increased simultaneously with alkalinity and base cations in early wet season. After the alkalization above, the pH and alkalinity suddenly declined with flushing of SO_4^{2-} in middle wet season. Possible mechanisms on the phenomena will be discussed with the internal cycle and atmospheric deposition.

Session 9: "Hydroecology"

Runoff and nutrient budgets in small experimental catchments in Istanbul, Turkey

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In terrestrial environments, nutrient budget of a catchment hydrologic system involves the cycling of water and nutrients. In systems approach; atmospheric and other sources are taken as inputs while export of nutrients via streamflow represents the output in catchments. We mostly benefit this approach if our objective is the estimation of output (nutrient or water yield) or identification of catchment system behaviour. The disadvantage of the approach is the need to monitor at least the deposition inputs and streamflow outputs and also the climatic variability which can be offset by paired watershed approach.

Experimental studies are conducted in small sized catchments and the results are scaled into larger ones for practical applications. Many management strategies have been proposed based on this approach during the last century. Therefore, small sized experimental catchments have been instrumented for this purpose. On the other hand, upscaling of the results has been widely discussed in hydrology because of many conflicting results at different sized catchments.

In this paper we analyze the input-output relationship of 3 adjacent catchments different in size (17.5, 71.9, 77.5 hectares) in relation with hydrology. The vegetation cover remained unchanged during a period of 5 years and no forestry treatments were performed. The only variation source was in the climatic parameters.

According to the results smallest catchment was more responsive to precipitation in winter months compared to larger ones but larger catchments have summer flows due to longer system memories. However, the runoff coefficients of the experimental catchments always remained under 0.2 indicating a strong vegetation evapotranspiration. We also calculated ionic inputs and outputs to compare and discuss on the catchment size.

Session 9: “Hydroecology”

Evaluating the effect of drought on inner-alpine coniferous trees: an approach based on sap flow measurements

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According to the IPCC Report (2007), mean global surface temperature is expected to increase by 1.5°- 4.5°C during the course of the current century, whereas precipitation patterns may not change significantly (Breda et al. 2006). As a consequence, transpiration of forest trees and stands may be altered along with soil water availability.

A dry inner-alpine open *Pinus sylvestris* forest (*Erico-Pinetum typicum*; *Pinus sylvestris* 90%, *Picea abies* and *Larix decidua* 10%) at Haiming (47°15`N, 10°51`E), provides ideal conditions for studying the effect of predicted climate warming on conifers. For enhancing soil drought we installed a transparent roof construction at 1.3 m above the forest floor to prevent precipitation to reach the soil. The roofed area covered 200 m² and included 15 trees (five individuals from each tree species). A respective number of trees each served as controls in the absence of any manipulation. Withholding of precipitation started in April 2011 and will be sustained throughout the growing seasons of 2011 and 2012.

In 2011 withholding of precipitation caused a continuous decline in soil water availability down to < 5%vol. Potential effects of soil water shortage on the physiological behavior and the isotopic carbon signature of the tree species under study will be discussed.

Session 9: "Hydroecology"

Modeling Suspended Sediment Amount Using Artificial Neural Network in Forested Watershed

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Artificial Neural Network (ANN) models used in the watershed, regardless of the system behavior, the mechanism and characters of the watershed, mathematically is presented by a set of behavioral functions. The behavior functions in ANN models, which simulate the behavior of the system functions, are structures with the optimum weight values of relationship between input and output data of watershed determine the optimal relationship of weight values. In this study, the suspended sediment amounts and runoff values carried by stream measured in forested watershed. Runoff and suspended sediment amount were used for calibration model and prediction. Model outputs were examined with observed suspended sediment concentration. This model performance was also compared with the multi linear regression (MLR) model structures. Furthermore, The mean square error (MSE), root mean square error (RMSE), mean absolute error (MAE) and the determination coefficient were used as comparison criteria. With ANN algorithm, determination coefficient was higher (R^2= 0.97) and comparison criteria results were optimum between the observed values and the estimated suspended sediment amount. Another important inference was that ANN method is one of the best forecasting methods considering peak values. Consequently, the modeling results indicated that it is a successful method between runoff and suspended sediment amount.

Session 9: Hydroecology

Recovery of rewetted beech saplings after drought: A ^{13}C labelling experiment

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Drought reduces the carbon assimilation and decouples aboveground and belowground processes, however, little is known about the response of beech saplings to rewetting. This study aims to assess the C allocation at dry and rewetted soil conditions.

In autumn 2010, thirty 5-year-old beech saplings from a forest site were transplanted into 20 l containers and subjected to different levels of drought in 2011 (range of no water limitation to severe drought). Photosynthesis and soil respiration were separately measured during the experiment. In late August, the saplings were individually labelled with ^{13}C-depleted CO_2 (-47δ‰) in a climatized chamber. The isotopic signature of leaf and soil respiration was measured 9 times during the following 6 days. Five days after rewetting, a second label was applied (99atom-% $^{13}CO_2$). The isotopic signature of different plant compartments was analyzed 12 days after the second labelling upon harvest. We calculated a ^{13}C mass balance to assess the fate of assimilated C in each sapling.

Photosynthesis decreased by 75% in plants under most severe drought. The first labelling pulse revealed an increasing retention time of assimilates in the leaves and a delayed transport to the roots under increasing drought. After rewetting, photosynthesis attained the level of the non-limited saplings within 3 days. No difference persisted in the velocity of assimilate transport after rewetting. Nevertheless, the ^{13}C mass balance revealed a significantly higher aboveground respiration and less C investment in biomass formation in the drought-stressed plants. Stressed but rewetted plants allocated relatively less ^{13}C to the root compartment (44%) than control plants (78%).

We conclude that beech saplings recover quickly even from extreme drought stress, although transitory effects upon drought stress prevail in carbon allocation, possibly due to repair mechanisms and enhanced respiration.

Session 9: "Hydroecology"

The effect of the soil properties on the chemical composition of spring waters (Tatra Mts., Poland)

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Geological structure of The Tatra Mountains is very complex and their geo-ecological zonation is well developed, therefore they are characterized by a very large diversity of natural environment. The area of Tatras is dominated by lower- and upper-montane forests, above which there are sub-Alpines and Alpines vegetation. The aim of this study was to identify the correlation between the soil properties and the chemical composition of spring waters in the high-mountain area of the Polish Tatras. Data concerning the chemical composition of water were derived from the project carried out in 2007-2009, entitled 'Factors determining spatial variability and dynamics of water chemical composition in the Tatra National Park (N 305 081 32/2824)', during which the area of the Polish Tatras was hydrochemically mapped twice, each time collecting 1505 samples of different types of water. The chemical composition of water was analyzed using ion chromatography (DIONEX ICS-2000). The chromatographic system was programmed to identify both anion and cation content (AS18-4mm and CS16-5mm columns). The concentration of 14 ions was determined. To investigate the problem, chemical composition of water from 1003 samples was selected and data on soil properties were derived from a detailed soil map. Shallow, low discharge springs were selected for the study: 386 springs of discharge up to 0.1 L/s, 482 up to 1 L/s, and 135 up to 9L/s. The soil cover of The Tatra Mountains is very diverse and fragmented (slotted), as it reflects the vertical and horizontal complexity of the natural environment. The soils of The Tatra Mountains may be acid or alkaline, they may have shallow and deep soil profile and they may be very permeable or less permeable. The proposed discussion will consider the effect of various soil properties and land cover (e.g.: forest, dwarf-pines, alpine meadow) on the chemical composition of water.

Session 10: Mechanisms of Action and Indicator Development

Impact of elevated ozone concentration on plant and viral pathogen interaction

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There is a range of complex secondary effects of ozone impact on plants that are not considered in current risk assessment. Therefore, there is an urgent need to develop approaches linking the ozone-caused effects with performance of individual plants, species interaction, maintenance of disease resistance, biodiversity and adaptability of the whole ecosystem.

It is well established that plant susceptibility to fungal, bacterial and viral plant pathogens may be significantly altered by air pollutants. However, the effect of elevated ozone concentration on viroid RNA and plant sensitivity to ozone remains not known. This study aimed at finding out if the elevated ozone concentration may change relationship between plant and viroid pathogen. The viroid infectivity and spread within plant was tested by phenotype expression and molecular methods and differences caused by acute ozone exposures were determined. Significant effect of the elevated ozone concentration on plant viroid interaction was observed. between plant and viroid pathogen.

This research was funded by a grant (No. MIP – 119/20119) from the Research Council of Lithuania.

Session 10: Mechanisms of Action and Indicator Development

Sensitivity comparison of single and combined effects of peroxides and ozone on leaf injury and chlorophyll content among three cultivars of *Brassica rapa*

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Peroxides always coexist with ozone in the air and cause severe damage to most of vegetables and plants when combined with O_3. The objective of present research is to investigate the single and combined effects of peroxides and O_3 on visible leaf injury and chlorophyll content and to find out the sensitivity difference among three cultivars of *Brassica rapa*. Two cultivars Misugi and Andowase of *Brassica rapa* var. perviridis and a cultivar Maruba of *Brassica rapa* var. glabra were investigated under three exposure conditions including control plot (free O_3; C-plot), single ozone plot (O_3 50 ppbv; O plot) and combined O_3 (50 ppbv) and peroxides (4-5 ppbv) plot (OP plot). Visible foliar injury was examined 1 – 2 days interval. SPAD index for evaluating chlorophyll content was measured four days interval. We found that all three *Brassica rapa* cultivars showed the same damage tendency which OP plot caused more severe damage on leaf injury and chlorophyll content than O plot. Leaf injury O_3 dose response of Andowase showed more sensitive than that of Misugi. Comparison of decrease in total chlorophyll content among three cultivars showed that Maruba was the greatest decrease and followed by Andowase and Misugi. It concluded that Maruba was the most sensitive while Misugi was the most tolerant cultivars on both leaf injury and chlorophyll content for both single ozone and combined peroxides and ozone.

Session 10: Mechanisms of Action and Indicator Development

Responses of native broadleaved woody species to elevated ozone in subtropical China

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To assess ozone sensitivity of subtropical broadleaf tree species and explore possible underlying mechanisms, six evergreen and two deciduous native species were exposed to either charcoal-filtered air or elevated O_3 (E-O_3, ~150 ppb) for one growing season. Initial visible symptoms were observed in deciduous species when AOT40 value reached 10 ppm.h and in evergreen species when AOT40 value was more than 20 ppm.h. E-O_3 had an overall negative effect on the growth as indicated by significant decreases in shoot and root biomass as well as specific leaf mass. The species which first showed visible symptoms also had the largest reductions in biomass. E-O_3 induced significant reductions in light-saturated photosynthesis rate (A_{sat}), total chlorophyll content and total antioxidant capacity, while significant increase in MDA content in two deciduous species and two evergreen species (*Cinnamomum camphora* and *Cyclobalanopsis glauca*). Except *C. glauca*, however, E-O_3 had no significant effects on stomatal conductance (g_s), total phenols and ascorbate contents. Across eight species investigated, AOT40 values at initial symptom onset showed significantly negative correlations with E-O_3-induced reductions in total biomass, A_{sat} and total chlorophyll content. Difference in O_3 sensitivity among all species was strongly attributed to specific leaf mass rather than g_s. Furthermore, foliar morphology, e.g. densely fine hairy, could not be neglected as possible reasons to explain O_3 tolerance of *Neolitsea sericea*. This study suggests that some subtropical tree species will be threatened by rising O_3 concentrations in the near future.

Session 10: Mechanisms of Action and Indicator Development

Ozone develops sluggishness of stomatal light response progressively in Siebold beech (*Fagus crenata*)

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We investigated the effects of ozone and leaf senescence on steady-state stomatal conductance and stomatal response to light variation. Measurements were carried out in a free-air ozone exposure experiment on a representative deciduous broadleaved tree species in Japan (*Fagus crenata*). Both steady-state and dynamic stomatal response to light variation varied intrinsically with season due to leaf senescence. Ozone caused a reduction in steady-state stomatal conductance. Also the ozone-induced increase in time for stomatal closing and the reduction in the light-saturated photosynthetic rate developed progressively. These findings suggest that ozone reduces the ability of plants to adapt to a fluctuating light environment under natural conditions, and therefore impairs plant growth and ability to control water loss.

Session 10: Mechanisms of Action and Indicator Development

Comparative measurements of sap flow and trunk radial shrinkage in mature trees of two co-occurring oak species

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Since drying climate was considered to be one of the main triggering factors behind the oak decline during the ’70ies and ‘80ies of the last century the aim of our study was to compare the fluctuations in water balance of sessile oak (*Quercus petraea* [Matt.] Liebl.) and turkey oak (*Quercus cerris* L.) in the mixed forest stand of Síkfőkút LTER site (North-eastern Hungary). Water relations of mature sample trees were monitored by continuous measurements of trunk sap flow (Granier’s heat dissipation method) and radial shrinkage (measured with radius dendrometers) after cessation of trunk radial growth (from 2nd week of July) in the vegetation period of 2011.

Remarkable nighttime sap flow density was found in all sample trees during the investigated period. Changes of nighttime sap flux density correlated linearly with air vapor pressure deficit (VPD) between 10 p.m. and 4 a.m. which could refer to cuticular water loss.

During unclouded days turkey oak maintained its daily maximum sap flow density for longer period than sessile oak. The social position within forest stand influenced remarkably the sap flow density and radial contraction that resulted in temporal and quantitative differences between trees of the same species. During dry period trees in denser parts of the stand exhibited larger diurnal radius contraction than during moister period. However, trees with less competitive pressure performed more or less the same contraction under both conditions. In addition to root competition the shading effect of neighboring trees was also found to be an important factor to affect trunk water status of sessile oak. Daytime means of sap flow density correlated with VPD and PFD (photon flux density) more strongly than with the potential evapotranspiration (PET, Hargreaves and Samani 1985) in both species. The study was performed with the support of OTKA No.68397 and TÁMOP-4.2.2/B-10/1-2010-0024, Life08 ENV/IT/000399.

Session 10: Mechanisms of Action and Indicator Development

Stomatal sluggishness responses to ozone at different light intensities

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Ozone exposure increases forest susceptibility to drought, as well as to pests, windstorms and fire. The mechanisms are unclear. Ozone is known to reduce stomatal conductance (Wittig et al. 2007) which should improve water control. In contrast, several Authors observed that ozone exposure increased transpiration in excised twigs/leaves (e.g. Barnes et al. 1990) whose causes, however, were unclear. Focusing on the dynamics of stomatal responses to ozone exposure in an ozone-tolerant Mediterranean sclerophyll species, *Arbutus unedo*, Paoletti (2005) found that stomatal responses to fluctuating light and abrupt water stress were slower after ozone exposure, while steady-state stomatal conductance did not differ in charcoal-filtered control and ozone-exposed plants. This was the first experimental proof of the mechanism postulated by Keller and Hassler (1984) and called stomatal sluggishness.

This study aims at quantifying stomatal sluggishness responses to environmental variables (light and ozone) in an ozone-sensitive plant species. Our research plant is *Phaseolus vulgaris* L. (snapbean) cultivar S156, which is an ozone-sensitive plant developed in North Carolina. One leaf per plant was exposed to low (3.7 ppb) or acute (102.6 ppb) ozone exposure for one hour. Exposure was carried out by a custom-made web-fumigation system. Dynamic stomatal responses to leaf excision (in order to quantify sluggishness) were measured by a portable gas exchange analyser (CIRAS-2) during 90 minutes after the ozone exposure. Light was manipulated in order to carry out these measurements along a range of values (200, 1000 and 1800 PAR), one measurement per leaf, according to a completely *randomized split plot block.*

Ozone exposure increased WWR duration at 1800 PAR more than at 1000 and 200 PAR. After ozone treatment, the time of response (WWR duration) changed between 16-26 min at 1800 PAR; 10-19 min at 1000 PAR; and 8-18 min at 200 PAR. Ozone also reduced the degree of stomatal closure over time (Δgs) at all light intensities (200, 1000 and 1800 PAR). Steady-state stomatal conductance significantly decreased after ozone fumigation at 1800 PAR, while at middle (1000 PAR) and low light (200 PAR) ozone exposure did not induce a significant change.

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Session 10: Mechanisms of Action and Indicator Development

Mycorrhizal status of poplars exposed to ambient ozone and treated with the antiozonant ethylenediurea

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Tropospheric ozone is an important phytotoxic air pollutant which level has been continuously increasing. In order to prevent ozone injury and growth reductions in forest trees, the antiozonant ethylenediurea (EDU) has been used. Valuable information about physiology of forest trees can be provided by investigating the structure of mycorrhizal community.

The aim of this work was to examine the presence of mycorrhizal fungi in ozone sensitive poplar clone exposed to ambient ozone and treated by EDU in order to study tree responses to ozone pollution and the potential protective role of EDU.

Identification of the fungal partner in ectomycorrhiza was performed by combining morphological and anatomical characterization with molecular identification. Ectomycorrhizal community structure was analysed and diversity indices were calculated. Colonization of poplar roots by ecomycorrhizal fungi, arbuscular mycorrhizal fungi, dark septated fungal endophytes and other fungi was evaluated using the intersection method.

In the treatment with EDU a higher total number of roots compared with control (vital mycorrhizal, old nonturgescent and nonmycorrhizal fine roots) was found. Also, the number of ectomycorrhizal types, Shannon-Weaver diversity index and Species richness index were higher in the treatment with antiozonant. Root length colonization with arbuscular and ectomycorrhizal fungi was higher in control, while colonization with fungal endophytes and other fungi was higher in the treatment with EDU.

Results of this work showed that EDU could protect ectomycorrhizal fungi from ozone stress but further researches are needed.

Acknowledgements. The study was done under COST-STSM-FP0903, the Research Programme P4-0107 of the Slovenian Forestry Institute and project III 43007 of Republic of Serbia

Session 10: Mechanisms of Action and Indicator Development

Diurnal changes in photosynthetic parameters of Populus tremuloides, modulated by elevated concentrations of CO_2 and/or O_3 and daily climatic variation

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The diurnal changes in light-saturated photosynthesis (Pn) under elevated CO_2 and/or O_3 in relation to stomatal conductance (g_s), water potential, intercellular [CO_2], leaf temperature and vapour-pressure difference between leaf and air (VPD_L) were studied at the Aspen FACE site. Two aspen (*Populus tremuloides* Michx.) clones differing in their sensitivity to ozone were measured. The depression in Pn was found after 10:00 h. The midday decline in Pn corresponded with both decreased g_s and decreased Rubisco carboxylation efficiency, Vc_{max}. As a result of increasing VPD_L, g_s decreased. Elevated [CO_2] resulted in more pronounced midday decline in Pn compared to ambient concentrations. Moreover, this decline was more pronounced under combined treatment compared to elevated CO_2 treatment. The positive impact of CO_2 on Pn was relatively more pronounced in days with environmental stress but relatively less pronounced during midday depression. The negative impact of ozone tended to decrease in both cases.

Session 10: Mechanisms of Action and Indicator Development

Phenotypic plasticity and limits of adaptation in birch under climate change

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Under rapid climate change phenotypic plasticity, rather than genetic diversity, will play a crucial role in allowing plants to survive in adverse environmental conditions. Very little is known of plasticity of trees, and one of the key questions is whether the northern tree populations can adapt quickly enough to cope with the rapid environmental change. If there are differences among tree origins from different latitudes in e.g. phenology, growth and photosynthesis, the global warming may affect populations at the northern and southern edges of the boreal forest in a different way.

We have established common garden experiments with silver birch (*Betula pendula* Roth) latitudinal origins in three locations: southern (60°N), central (62°N) and northern (67°N) sites. These identical reciprocal transplant experiments represent in total 27 randomly selected birch genotypes from six origins from a latitudinal cline from 60°N to 67°44'N. The clonally reproduced birch genotypes have been planted on common gardens during summer 2010.

The main objectives of the study are to establish the phenotypic variation in Finnish silver birch, and explore the traits that show the variation. By comparing the phenotypes of these trees at common gardens, we can discern the traits with strong genetic control (non-changing traits at different environments) from the phenotypic plasticity (changing traits). We have studied phenology, growth, leaf gas exchange and leaf characteristics, such as stomatal and trichome density and specific leaf area.

Preliminary results indicate latitudinal variability in phenology among the origins, showing that southern genotypes have longer growth periods than the northern origins at all study sites. If the cold acclimation of southern genotypes occurs early enough, the longer growth period may provide them a better competitive capacity. There are genotypic differences in leaf traits and gas exchange rates. These differences may affect acclimation capacity of birch population to changing environment.

Session 10: Mechanisms of Action and Indicator Development

Morphophysiological characters of *Pinus sylvestris* near main local pollution sources of Lithuania: past, present and future

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Since late 80s worsening forest tree condition through the world provoked strong concern about environment quality. When explaining possible reasons of this phenomenon attention immediately has been focused on expanding industrial pollution. Very soon adequate measures for emission cutting were undertaken by advanced countries. In some other countries pollution prolonged to be a problem for a longer time span and there are corners of the world where till now it causes serious injuries. Testing aerial pollutant effects on forest trees huge variety of methodologies were applied bridging observations of trees in the field with controlled condition experiments and precise laboratory assessments. Significant part of documented effects of gases and other harmful deposits on vegetation were achieved applying pollutant concentrations much higher compared to situations in urban or industrial districts. Among other shortcomings assessing negative industrial effects were observations limited in time and space, which could not provide insight into tree physiology under long lasting industrial emissions nor climate fluctuations. Special stress has been made to detect latent injuries of the plants before visible injury appears under influence of realistic level pollution. Since 60s-70s main sources of industrial pollution in Lithuania were an oil refinery, a cement factory and a nitrogen fertilizer plant. Within 20 years span testing and monitoring of *Pinus sylvestris* morphological-physiological features near these factories took part. Following parameters of the needles were tested: morphology, histology, fluctuating asymmetry, surface microstructure, wettability, wax amount, water loss from excised needles, concentration of elements comprising factory emissions, concentration of free arginine, and composition of essential oil. Also assessments of bark acidity, herbaceous species of the stands took part. Suitability of these characteristics is discussed in terms of specificity of industrial pollutants, low level pollution and climate extremes.

Session 10: Mechanisms of Action and Indicator Development

Metabolic responses of birch leaves to increasing air humidity

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Water vapor is a “greenhouse gas”, affecting water and energy budget of plants, but our knowledge about the long-term impacts of changing air humidity on trees and forest ecosystems is still marginal and remains to be investigated. Responses of silver birch (*Betula pendula*) and hybrid aspen (*Populus tremula* x *P. tremuloides* Michx.) to different air moisture conditions have been studied in Estonia since growing season 2007 at Free Air Humidity Manipulation (FAHM) site located at Järvselja Experimental Forest District in South-eastern Estonia. The aim of our study is to determine metabolic changes of birch and aspen leaves developed under increasing air moisture. We perform a comprehensive metabolite profiling for primary and secondary metabolites, including organic acids, sugars, sugar-alcohols, sugar phosphates, amino acids and phenolic compounds. The results will be integrated with structural responses (for example trichome density) and physiological measurements (gas exchange, leaf hydraulic conductance, xylem flux, growth rate). Later on, these metabolic shifts will be used as a “map” for more detailed gene-level studies. In this presentation we show the first results from primary metabolomic analyses of birch.

Session 10: Mechanisms of Action and Indicator Development

Phenological dynamics of mature *Quercus petraea* [Matt.] Liebl. trees based on multi-seasonal analysis of leaf-scale morphology and chlorophyll fluorescence measurements

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The aim of this study was to describe general tendencies of leaf phenology in canopy of sessile oak (*Quercus petraea* [Matt.] Liebl.) trees in the mixed forest stand of the Síkfőkút LTER site, North-eastern Hungary. Leaf maturation was monitored by means of leaf morphological traits and dark adapted chlorophyll fluorescence parameters from the onset of leaf expansion till the leaf 'mature' state in mid summer in seven growth seasons between 2003 and 2009. The investigated parameters of expanding leaves in upper and lower canopy positions were analyzed as the function of cumulative daily mean air temperature (summed from the reference point of DOY 100 and 11 °C as the threshold temperature). Expansion of leaf area (LA) and potential photochemical efficiency of dark adapted leaves (variable to ground chlorophyll fluorescence ratio, Fv/Fo) showed continuous and rapid increase with cumulative temperature in the early stage of leaf development till their seasonal maximum. Based on our regression model leaves needed 100 °C thermal time to become fully expanded irrespectively of their canopy position, Fv/Fo on the other hand reached its 'plateau' after 180 °C in shade and 300 °C in sun leaves respectively. Seasonal course in specific leaf area (SLA) was very similar to that of ground fluorescence yield of dark adapted leaves (Fo) with a strong increase at the start of leaf development (till 40 and 60 °C cumulative temperature for shade and sun leaves, respectively) and decreased steeply during further leaf expansion. Seasonal pattern of photoinhibition was also distinctive: in sun leaves the difference between midday Fv/Fo values measured after short (30 min) and long-term (24 h) dark adaptation indicated slowly relaxing photoinhibition both in spring and summer, while in shade leaves only in springtime.

The study was supported by National Research Fund OTKA No. 68397 and TÁMOP-4.2.2/B-10/1-2010-0024

Session 10: Mechanisms of Action and Indicator Development

Bioindications of ozone stress in foliage of Mountain pine (*Pinus mugo* subsp. *uncinata*) from the Catalan Pyrenees

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The Central Catalan Pyrenees have been experiencing high levels of tropospheric ozone with AOT 40 (Apr-Sept) ranging from 9.6 to 23 ppm•h increasing by more than 0.5 ppm•h per year over the last two decades. At the same time, foresters have expressed concerns about the vitality of Mountain pine, a dominant tree species growing at a high elevation in forests of this region with sensitivity to ozone so far unknown. The principal objective in this study was to survey Mountain pine stands for specific ozone injury and to validate the diagnosis with microscopy. Visible injury was recorded in 12 plots along two altitudinal and ozone monitoring transects in the spring of 2009. Typical ozone symptoms, in the form of tiny and diffuse greenish mottles centered on stomata lines of the needle light-exposed side, were observed on 2-year or older needles with some frequency but few morphological differences between plots; they were similar to those induced by ozone in another experiment using a FACE facility. After selecting a representative plot subsample, needles were collected with a view to detailed morphological and microscopical observations in light and electron microscopy, focusing on changes within mottling symptoms. Structurally, mottles were underlined by numerous changes in the cell wall and content structure – accumulation of intercellular material, wart-like protrusions on cell walls, cytoplasm condensation and disruption, picnotic nuclei, chloroplast degeneration, tonoplast blistering, massive lipid accumulation - peaking in the outer vs. inner mesophyll layers and in cells below the stomata. The macroscopic mottling morphology was caused primarily by chloroplast degeneration, including lower frequency and an area reduction of 76% on average compared to the inner mesophyll layers. Overall, structural changes in mottles indicated increased oxidative stress and hypersensitive reactions. Hence, besides Aleppo pine, Mountain pine is the second European pine species to be found with specific ozone injury as a reaction to ambient ozone.

Session 10: Mechanisms of Action and Indicator Development

Leaf area index (LAI) as indicator of stand productivity, health and biodiversity

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Leaf area index (LAI) is one of the most important structural characteristics of the forest ecosystem and forest productivity. It reliably represents the interaction between plants and their environment. Therefore in the present study we attempt to detect the indicational capacity of mature coniferous stands LAI to represent their condition and productivity, as well as underground vegetation diversity. The indirect method was employed to estimate LAI by different instruments: the HemiView system, and Canopy Analysis System SS1 SunScan and SUNFLECK PAR Septometer SF-80 sensors. The estimation of LAI was conducted with a multiple readings per plot placing the sensor at systematically located permanent observation plots, where crown transparency and volume of sample trees, as well as biodiversity and abundance of ground vegetation were parallel estimated.

The objectives of this study were to explore the relationships between sun radiation indices and LAI detected by different instruments versus stand productivity indices, crown transparency and underground vegetation diversity to assess the sustainability of forest ecosystem under the global environmental changes at Aukstaitija Integrated monitoring station in Lithuania. The significant correlation detected between the biodiversity of ground vegetation, their abundance, biomass of tree, crown transparency and LAI of forest canopy. Comparison of a 3 recently widely used instruments used for LAI estimation enabled us to suggest the best way for stand productivity and health assessment, and LAI application for large-scale ecosystem models developed to evaluate the effect of climate and air pollution changes on ecophysiological processes in terrestrial LTER sites.

Session 10: Mechanisms of Action and Indicator Development

Chamber measurements of CO_2 fluxes in a pine forest in Poland, Tuczno case study

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The Tuczno forest is 24m tall, 59 years old Scot's Pine (*Pinus sylvestris L.*) stand located in the northwestern Poland. CO_2 fluxes measurements were carried out at this site by means of the dynamic chamber technique since October 2010. Manual chamber measurements were carried out at the bottom of the forest at three locations dominated by different species (*Bryophyta* site 1, *Rubus* L. site 2, *Calamagrostis epieios* (L.) & *Rubus* L. site 3). Chamber campaigns were conducted every 3-4 weeks, only during cloudless conditions. Both, transparent and dark chambers were used for the measurements of NEE and Reco, respectively.

Results of chamber measurements indicated that the site dominated by *Bryophyta* sp. may be a net source of CO_2 by most of the day even in the middle of a vegetation period. The maximum NEE measured at 28th of June 2011 in this site did not exceed -1.6 µmols m^{-2} s^{-1} (PPFD 1100 µmols m^{-2} s^{-1}). The other sites, characterized by higher amount of biomass, were more active in CO_2 assimilation, but the CO_2 fluxes at the same day did not exceed -2.2 and -2.5 µmols m^{-2} s^{-1} at the maximum PPFD, for site 2 and 3, respectively. Variations of NEE measured by chambers are however very high because of very frequent variations of PPFD measured below a forest canopy (due to shadowing). This process causes that the same microsite may turn from a net sink of CO_2 to a net source of CO_2 even in the middle of the day when the below canopy PPFD decreases below 150 µmols m^{-2} s^{-1}. Chamber measurements of CO_2 fluxes carried out in the bottom of a forest are difficult mainly due to unstable radiation conditions. Nevertheless, they are very useful and may help to better understand the C dynamics in a forest.

Session 10: Mechanisms of Action and Indicator Development

Tissue- and cell-level bioindications of climate change and air pollution in foliage of trees

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Plants quickly respond to constraints by environmental stressors with structural adaptations in the organs primarily affected. Structural changes are indicative of and develop simultaneously to modifications in the cell and plant physiology. However, they are more stable than the often transient physiological changes and, in the case of repeated stress events, they may become cumulative. Injury, visible with the naked eye, appears in a later phase and results principally from the development of necrosis. In response to various biotic and abiotic stressors, plants have evolved different stress or defense responses characterized by specific set of structural markers useful for diagnostic purposes and for understanding the stressed cells' physiology. The stress severity determines the kinetics of plant responses and is reflected by contrasted structural markers. Other environmental constraints, simultaneously affecting the plant health, can modulate the responses or determine in which tissue the symptoms first develop. They can provide supplementary bioindication clues but also complicate the diagnosis. Recent advances have provided substantial understanding of the herbaceous and tree species responses to various primary and secondary anthropogeneous air and soil pollutants. Still unclear is the response variability in plant families or biomes - as the tropical forests - so far little investigated and the interaction with other environmental constraints. With 1.5 vs. 0.6 °C temperature elevation during the last century in Switzerland vs. the rest of the world, the ongoing climate change has caused its first observable effects on forest ecosystems. Its principal consequence appears to be an increase in drought stress particularly in the already water-limited stands from the central Alps under a dry continental micro-climate. Depending on their timing during the year, dry spells elicit different types of structural reactions and carry-over effects in plants. Research on structural reactions can contribute to understanding the tolerance reactions and to selecting better resistant tree provenances for more stable forests in the future.

Session 10: Mechanisms of Action and Indicator Development

Structural bioindications of drought stress and tolerance in foliage of oaks under experimental climate forcing

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During the last century, the annual average temperature in Switzerland has increased by 1.5 °C. Recent modeling forecasts a further increase on average of 2.7-4.8°C until the end of the century. As a likely consequence, an altitudinal shift of existing ecosystems is expected and thermophilous species such as oaks should expand. To test the tolerance of Central European oaks to a warmer climate and determine their suitability for sustainable afforestation, a common garden experiment was conducted using the model ecosystem facility at WSL. During three years, young pedunculate, sessile and pubescent oaks were exposed to drier and warmer growth conditions by reducing irrigation (16-30%), passively increasing air temperature (+ 1-2°C) and combining both treatments. In this part of the project, the development of foliar injury at both macroscopic and microscopic level was assessed. During the third year of treatment, once the soil had dried out at all depths and the leaf water potential dropped below -1.3 Mpa, the treated oaks started to show visible foliar injury within their first flush. In the still green parts of symptomatic foliage, as well as in asymptomatic leaves, microscopic stress reactions were detected within most tissues and with little variation between species. The most striking symptoms included the advanced plasmolysis and cytorhisis of epidermal and lower mesophyll tissues causing a thinner leaf blade, the plugging of xylem veinlets, the degeneration of phloem and the near complete depletion of reserves. Altogether, the structural changes indicated that the stressed oak foliage suffered primarily from starvation. In a general way however, the treated oaks were remarkably tolerant to drought stress. Within foliage, this was achieved by controlled degeneration and cell death processes affecting in priority the less essential tissues whilst those needed for resuming the foliage gas exchange function upon release of the drought stress conditions, were maintained in a still functional stage.

Session 10: Mechanisms of Action and Indicator Development

Photosynthetic traits of *Fagus crenata* and *Quercus crispula* sapling grown under free air ozone exposure

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We established free-air ozone (O_3) exposure system for evaluating ecophysiological response to O_3 of *Fagus crenata* and *Quercus crispula* under field condition. In this presentation, we report the brief overview and performance of our free-air O_3 exposure system and photosynthetic responses to O_3 of *F. crenata* as well as *Q. crispula*, representative deciduous tree species in cool-temperate forest in Japan. The exposure system was located in Sapporo Experimental Forest, Hokkaido University, in northern Japan. Ten-year-old saplings of *F. crenata* and *Q. crispula* were exposed to an experimentally enhanced O_3. The target O_3 concentration ([O_3]) was 60 nmol mol^{-1} during daytime. The first year exposure was started from the end of July to early November 2011. Control site was also established with the other trees of the same age under ambient conditions (daytime mean [O_3] was 25.7 nmol mol^{-1}). The [O_3] at the center of the system was continuously monitored by active O_3 analyzer. Horizontal distribution of [O_3] at two heights (2.5 and 4 m) was determined by passive samplers. In early October, leaf gas exchange was measured using an open gas exchange system. Although slightly lower mean [O_3] (54.4 nmol mol^{-1}) than target value and horizontal variation of [O_3] were observed, the O_3 exposure was satisfactory conducted. The exposure to O_3 significantly reduced light-saturated net photosynthetic rate of *F. crenata*, while there was no significant effect was found in *Q. crispula*. We also found significant decrease in the maximum rate of carboxylation and the maximum rate of electron transport in the photosynthesis of *F. crenata*, whereas stomatal limitation of photosynthesis was not affected by O_3. Therefore, we conclude the O_3-induced reduction in light-saturated photosynthetic rate observed in *F. crenata* was not because of stomatal closure, but because of photosynthetic activity at chloroplast.

The request poster: Session 11 “Modeling and Risk Assessment”

Single and combined effects of organic peroxides and ozone on visible foliar injury and chlorophyll content of two vegetable species

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Peroxides always co-exist with ozone because peroxides are formed by reaction with ozone and volatile organic compounds although the peroxides concentrations are mostly below several ppb. But recently the concentration has been increasing in the world. The peroxides in the air are mixture of non organic which is hydrogen peroxide (H_2O_2) and many kinds of organic peroxides such as methyl hydro peroxide (MHP). Among the organic peroxides in the air MHP is the major content species. The mixed peroxides are reported very harmful even in several ppb when combined with ozone (Chen et al., 2005; Chen et. al., 2010). It is known that single H_2O_2 has no harmful, and we found that combined several ppb H_2O_2 and 50ppb ozone fumigation induced the same foliar visible injury with 50ppb single ozone. But exposure experiment on combined organic peroxides and ozone and single organic peroxides have not been carried out until now. Then the objective of the present research is to find out whether single organic peroxides (MHP; several ppb) and combined MHP (several ppb) and 50ppb ozone are harmful to plants. If both of single and combined fumigation are harmful, then we can conclude that the cause of mixed peroxides when combined with ozone is organic peroxides. We used Japanese radish and Chinese cabbage as materials. Both species are very sensitive to single ozone and combined mixed peroxides and ozone. It is found that both of single MHP and combined MHP and ozone caused foliar visible injury and decrease in leaf chlorophyll content for both vegetables. Then these facts imply that the main cause of injury by mixed peroxides when combined with ozone is organic peroxides such as MHP.

The request poster: Session 11 "Modeling and Risk Assessment"

Forest growth and carbon balance under climate change: simulation experiments on forest monitoring plots in Central Europe

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We analysed climate change impact on the growth and carbon balance of Norway spruce (*Picea abies*), European beech (*Fagus sylvatica*), and Turkey oak (*Quercus cerris*) stands in Central Europe. Two future time periods were considered: 2021–2050 and 2071–2100. The period 1961–1990 was used as reference. Forest growth simulations were based on the SIBYLA tree growth simulator (an empirical model), and carbon cycle-related simulations were performed using BIOME-BGC (a process-based biogeochemical model). We strived to perform a multi-model assessment of future forest stand development using those models, and to discuss the benefits and caveats of such approach.

Three intensive forest monitoring plots in Slovakia (Central Europe) were investigated – IMP 54-201 that represents 85 year old stand of Turkey oak; IMP 54-206 that represent 82 years old stand of European beech; and IMP 54-203 that represents 71 years old stand of Norway spruce. Diameter and height increments for the period ca 1998–2010 were used for calibration of used models. A multi-model assessment based on SIBYLA and BIOME-BGC simulations suggested that oak production will either remain the same as in the reference period or will increase. Future production of beech seems uncertain and might decline, while spruce production is likely to increase. Those conclusions are valid for approximate zone of the ecological optima of the addressed species, where investigated forest monitoring plots were allocated.

Acknowledgement: This research was supported by project of the Slovak Research and Development Agency „Spatial and ecophysiological aspects of climate impact on forest ecosystems under climate change" under contract No. APVV-0111-10.

Session 11 “Modeling and Risk Assessment”

Comparison between POD and AOT40 in French Italian forest

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In Europe, especially in the Mediterranean region, background ozone levels are gradually increasing. At present, the European standard for forest protection is the AOT40 index, based on the atmospheric ozone concentrations. Many studies have suggested that the stomatal flux-based approach is scientifically-sound and would be a useful tool for ozone risk assessment. In fact, stomatal uptake is limited by drought during the summer in Mediterranean regions where ozone concentrations are high. Ozone pollution is pronounced in regions with strong photochemical activity, such as the Mediterranean basin. O3 levels regularly exceed the critical thresholds for forests in the given region.

A comparison of the maps of total stomatal ozone uptake (POD0), threshold-based phytotoxic ozone dose (POD1), and concentrations exceeding 40 ppb (AOT40) for Pinus halepensis and Fagus sylvatica was conducted in South-eastern France and North-western Italy. In order to calculate ozone fluxes, meteorological data (air temperature, relative humidity, soil water content and solar radiation), soil data and ozone concentrations for 2010 and 2011 were calculated from the coupled MM5-CHIMERE modelling system. The CHIMERE multi-scale model is primarily designed to produce daily forecasts of ozone, aerosols and other pollutants and make long-term simulations for emission control scenarios. The chemical and transport model CHIMERE (IPSL/LMD) is coupled with the MM5 meteorological model (NCAR). For this work data has been provided at 1-h temporal resolution and spatial resolution of 9×9km across a study area.

The comparison of obtained maps shows the different distribution of AOT40 and flux in the selected region. Statistical analysis has been made in order to identify the parameters more effective on POD.

The request poster: Session 11 "Modeling and Risk Assessment"

Stomatal ozone fluxes in leaves of Quercus robur and Quercus rubra seedlings exposed to ambient ozone in Plana Mountain

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Ozone dose received by the plants is largely driven by stomatal opening and is a function of ambient ozone concentration and stomatal conductance to water vapor. This relationship is decisive in estimating ozone flux into leaves and ozone response in plants. The stomatal flux is considered the most reliable index of potential ozone damage. In this study calculation of stomatal ozone fluxes in leaves of 3-year old seedlings of *Q. robur* and *Q. rubra* were made by taking into account the ambient concentrations of ozone and leaf stomatal conductance to water vapour. Seedlings were exposed to ambient ozone in Plana Mountain (Bulgaria) during the growing season of 2009. Data were assessed through field gas-exchange measurements and monitoring of ozone pollution over one season. Ozone uptake was species-specific and was driven by leaf related variables. In *Q. robur* peak ozone flux occurred during the late summer, simultaneously with peak ozone concentrations, whereas in *Q. rubra* peak ozone flux preceded peak ozone concentrations. Resistance to ozone entry into leaves was discussed in relation with physiological features of tree seedlings and correct risk assessment.

Session: “Biodiversity and Alien Species under Global Pressure”

Sensitivity of alien coniferous species outside their natural distribution range to recent climatic condition

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The growth of alien tree species and their effect on native tree species are increasingly growing of concern due to rapidly changing climatic conditions and possibilities of tree species exchanges when southern tree species are moving to more northern areas. Therefore in the present study employing the dendrochronological analysis we attempted to assess the sensitivity of four alien coniferous tree species growing outside their natural distribution range to local unfavourable climatic conditions – frost over the dormant period and heat over vegetation. Effect of the mean monthly temperature and amount of precipitation on tree ring width series was detected employing correlative analysis performed with software “Statistica”. Four alien tree species: European Black Pine (*Pinus nigra*), Eastern white pine (*Pinus strobus*), European larch (*Larix deciduas*), and Douglas-fir **(***Pseudotcuga menziesii***)** as well as two native tree species – Scots pine and Norway spruce - were examined on the planted experimental site located in the middle of Lithuania. Data revealed that until the very beginning of 1990s tree ring width decrease, or growth occurred following the common ageing process. After that radial increment of the considered tree species started to increase. Norway spruce trees demonstrated the most intensive and significant trend towards ring width increase by more than 0.15 mm per year. The rate of growth increase of the considered three pines trees species was a little lower and made about 0.1 mm per year, and the least was increase of Douglas-fir tree ring width, about only by 0.05 mm each year. The growth of larch trees was different from the other considered tree species. At the beginning of 1940s, when the most significant effect of tree age on tree ring width formation was over, larch trees started demonstrating stable growth at the level of 1.5 mm per year which has been continuing until now. Obtained results allowed to conclude that recent climatic conditions in north eastern part of Europe is the most acceptable for growth of European larch and Eastern white pine. From native coniferous species Norway spruce demonstrated similar growth tendencies. The most sensitive to unfavourable climatic condition seems to be prevailing in Lithuania Scots pine and alien tree Douglas-fir trees.

Session: "Biodiversity and Alien Species under Global Pressure"

Potential of some alien tree plantations in Lithuanian forests

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More than 50 species of alien trees are documented in Lithuanian forests. Some plantations of these species, especially warmth-tolerant, could be expanded under changing climate in future. Our research focused on forest plantations of European larch (*Larix decidua* Mill.), European beech (*Fagus sylvatica* L.) and northern red oak (*Quercus rubra* L.). Studied plantations were 45-51 year old and were established on *Stagnic Luvisols.* The plantations of larch were distinguished as the most wood productive (510-810 m^3 ha^{-1}) whereas beech and red oak stem wood mean production (about 390 m^3 ha^{-1}) was by 1.7 time lower. Meanwhile, the mean mass of foliar litterfall ranged from 2.0 to 2.6 Mg DW ha^{-1}in larch and beech stands, respectively, and to 3.5 Mg DW ha^{-1} in red oak stands. However, due to higher decomposition rate of litterfall only fragmented OF horizon of soil organic layer was found in beech and red oak plantations. Consistently, the conditions for natural regeneration in these plantations, especially in those of red oak, were more favourable. Beech and red oak, on the other hand, according to pH, Al ions and fulvic acid concentrations had similar effect to Norway spruce (*Picea abies* (L.) H. Karst.) on mineral topsoil chemistry. In larch plantations, in addition to OF horizon, organic humus OH horizon was found. Despite that, the balance between the accumulation and the leaching of nutrients was detected. These findings suggest that the expansion of European larch plantations is purposeful in Lithuanian forests, where larch was native till XIV century.

Acknowledgement. This research was funded by a grant (No. LEK-19/2010) from Research Council of Lithuania.

Session: “Biodiversity and Alien Species under Global Pressure”

The spread and invasiveness of *Q.rubra* and *F.sylvatica* – an introduced forest tree species in Lithuania

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Alien forest tree species were introduced in a variety of ways in Lithuania. Some were introduced by direct transfer, while others were brought from neighbouring countries and already naturalised or possess some degree of adaptedness. *Quercus rubra* was brought to Lithuania more than a hundred years ago from other European countries. *Fagus sylvatica* was introduced in Lithuania in the nineteenth century.

The most successful spread of *Q. rubra* was observed in oak and pine stands, on a medium-rich well-drained soils. *F. sylvatica* spread was much less abundant and perspective. The undergrowth was usually formed in beech stands. Soil and humidity indexes optimal for the beech spread were similar to those of red oak. The results show that of all alien forest tree species the spread of red oak is the most distant from the mother tree. The mean distance for red oak made 240 meters and for beech – 212. The mean number of undergrowth trees was 1000 and 790 per ha, respectively. Intensity of both species spread was the largest in the northeast direction.

Higher density of the first storey had a positive effect on the abundance of red oak undergrowth below 0.5 meter height and negative to the abundance of the red oak undergrowth above 3.0 meters height. High underbrush density had strong negative effect on the number of undergrowth in both species, while herbal cover had a pronounced negative effect on the beech undergrowth alone.

The obtained invasiveness indexes for both forest tree species were lower than the average and indicated that the species were not invasive. Invasiveness index of beech was lower than that obtained for the red oak.

Session: "Biodiversity and Alien Species under Global Pressure"

Spontaneous hybrids between *Pinus mugo* and *Pinus sylvestris* at the Lithuanian sea-side

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Possibility of spontaneous hybridization between *Pinus mugo* and *Pinus sylvestris* in the sympatric populations at the sea-cost spit of Curonian Spit national Park in the western Lithuania was studied by the aid of morphological traits (female parent) and DNR markers (male parent identification). A specific feature of our material is that it consists of introduced populations for both the species into a topographically variable dune landscape.

The field inventory was carried out over the entire Lithuanian part of the spit and 203 individuals morphologically intermediate between *P. sylvestris* and *P. mugo* were investigated with the paternally inherited chloroplast DNA PCR-RFLP marker. The chloroplast DNA marker revealed that of the 203 individuals tested only 23 possessed the paternity of the other species than identified morphologically. Of these, 13 individuals were morphologically identified as *P. sylvestris* but possessed the cpDNA of *P. mugo* (putative hybrids with *P. sylvestris* (female) x *P. mugo* (male parent) and 10 individuals morphologically identified as *P. mugo* possessing the cpDNA of *P. sylvestris* and may be hybrids with *P. mugo* (female) x *P. sylvestris* (male parent). The rest of 177 individuals identified in the field inventory were assigned to the same species as morphologically defined and were considered as pure species. In conclusion, our study indicates a strong probability for spontaneous hybridization between *P. mugo* and *P. syvestris* in Curonian Spit NP.

Session: “Biodiversity and Alien Species under Global Pressure”

Recent new additions to the alien mycobiota in Lithuania

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Changing climate with milder winters and increased import of plants and plant-derived goods from the outside of the region have stimulated appearance and spread of some new fungi during the past two decades. Introduction of new fungi most likely is a result of unintended human activity such as transport of propagative plant material, of natural and semi-natural factors, appearance and effects of other alien and invasive species. During the last decade several new micromycete pathogens, such as *Dothistroma septospora* and *Lecanosticta acicola* causing, respectively, red band needle blight and brown spot needle blight of pines, and macrocyclic host-alternating rust fungus *Melampsoridium hiratsukanum* damaging alder trees have spread in Lithuania. Apart from these plant pathogens, the last decade has been distinguished by appearance and/or spread of some recently recorded alien macromycetes which are conspicuous and attract attention of the general public. Among these are such members of neomycota like a native to Australia saprobe *Clathrus archeri*, which was found for the first time in the Baltic countries; or saprobes spreading with substrates used in gardening - *Mutinus ravenelii* (native to North America) and *Stropharia rugosoannulata.* A weak parasite on woody plants, *Auricularia auricula-judae* has lately increased in numbers along with spread of the alien hosts – *Acer negundo* and *Sambucus* spp.

Four of the mentioned micro- and macromycetes (*D. septospora, L. acicola, M. hiratsukanum* and *A. auricula-judae*) were recorded in the Curonian spit, along with a first European record of a mycorrhizal macromycete *Boletellus projectellus* which is native to North America.

Session: "Biodiversity and Alien Species under Global Pressure"

Xylotrophic fungi in plantations of alien pine species, *Pinus mugo*, subjected to various disturbances in Lithuanian coastal zone

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Changing climate, high anthropogenic (recreational) pressure, fellings, forest fires and fungal diseases have a great impact on mountain pine (*Pinus mugo*) forest ecosystems that comprise a unique component of the Curonian Spit in western Lithuania. Forest fires not only result in disturbance of wood- and soil-inhabiting fungal communities, but also have an impact on the persistence of rot-causing fungi that are present in infected root systems. The occurrence of the root pathogens *Heterobasidio*n and *Armillaria* in root disease centres on burned and non-burned sites in *P. mugo* forest has been investigated (Lygis et al. 2010). Results of the study suggested that forest fires on sandy soil can reduce the occurrence of *H. annosum* s.s. in disease centres. Constant subjection of the coastal pine plantations to various disturbances allowed for studying the community dynamics of wood-inhabiting fungi in *P. mugo* following three disturbance scenarios: i) living stems - their cut stumps; ii) living stems - burned snags - their cut stumps; and iii) living stems - stems recently killed by annosus root rot - old snags of annosus root rot-killed trees. Isolations from 300 stem/stump bases (50 trees/stumps were sampled in each of the six sample categories) yielded 277 isolates representing 59 fungal taxa. Shift in fungal community structure following each disturbance scenario was considerable indicating that fungal communities are likely to evolve in different directions. With respect to its origin (cut, burned or killed by disease), dead wood might be inhabited by absolutely different microbial assemblages. *H. annosum* failed to infect fresh *P. mugo* stumps (or to persist in those) despite a high infection risk in the area. Fungal assemblages inhabiting wood of mountain and Scots pines were highly dissimilar suggesting that the ongoing displacement of *P. mugo* may lead to a loss of present mycodiversity in coastal forest ecosystems.

Session: “Biodiversity and Alien Species under Global Pressure”

Forest under impact of cormorant colony – plants, fungi, lichens, soil microorganisms and microarthropods

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The continental subspecies of the great cormorant (*Phalacrocorax carbo sinensis*) is an alien bird that spreads in the coastal forests of the Baltic region. The largest (3307 nests in the year 2011) and oldest cormorant colony in Lithuania (Curonian Spit) was studied for its influence on various components of pine forest ecosystem. Strong deviations from normality were registered for all studied objects. Increased contents of total N and P, increased pH, increased amount of organic matter (slower mineralization rates) and decreased content of Mg were found in soil of the colony area. Rugged terrain influenced some of the soil characteristics, at times enhancing the impact of the colony, expressed in the increased runoff. Biological properties of soil were altered as well: mycorrhiza was dead or significantly reduced, structure of microarthropod community (oribatide mite and acarids’ ratio) and micromycete/bacteria ratio was changed, the amount of actinomycetes decreased. The colony induced the decline of valuable plant community, included into the EU Habitats Directive Annex I list (2180 *Wooded dunes*). Vegetation was damaged both directly and indirectly through the pathogenic microfungi which damaged up to 100 % of their host plants in the most active parts of the colony. Territory of the colony and surrounding areas became a source for diaspores of alien and invasive plants (7 species of alien plants were recorded). Colony activities dramatically changed saprobic and symbiotrophic mycobiota which suffered severe reduction in species diversity and alterations in functional structure. The investigation results also revealed conservational conflict between important habitat and ornithological object, as the existence of the colony and especially its expansion are incompatible with protection of EU Habitats Directive Annex I community.

Session: "Biodiversity and Alien Species under Global Pressure"

Fungal community succession following crown fire in *Pinus mugo* stands and surface fire in *Pinus sylvestris* stands

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In the year 2006, a devastating crown-fire occurred in stands of *Pinus mugo* in Kuršių Nerija National Park (western Lithuania) resulting in the death of all trees, and a significant burn of the thick litter cover on sandy soil on a territory of ca. 230 ha. The edges of wild fire reached the stands of *Pinus sylvestris*, where it turned to the less damaging surface fire. Mycobiota was studied in the areas of both stand types for three subsequent years as well as in *P. mugo* and *P. sylvestris* stands located close to the unburnt ones. In the crown fire areas up to 100 % species of some fungi groups were eradicated and major decline in diversity of the other was observed in the first year after the fire. Surface fire was shown to be less terminal to mycobiota and even triggered more vigorous fruiting of some fungi. Pyrophilic species fruited on the first and second post-fire years at both fire type sites, but were nearly absent on the third year and were replaced by litter and soil saprotrophs at the crown fire sites and by symbiotrophs at the surface fire sites. Abundantly available burnt *P. mugo* sites, devoid from competitors, were favourable for some wood-inhabiting ruderal species of aphyllophorous fungi and they appeared numerously on the second and third year after the fire on charred stumps and logs. Qualitative analysis has demonstrated that mycobiota of burnt *P. mugo* sites showed the strongest differences from both unburnt stand types and differed significantly from the burnt *P. sylvestris* stands. No significant temporal change was observed for the unburnt sites, but was obvious in the burnt ones. The yearly changes of all burnt sites showed increasing similarity with the unburnt sites.

Session: “Biodiversity and Alien Species under Global Pressure”

Coarse woody debris: carbon and nitrogen contents and bryophyte diversity

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Data of the second Lithuanian National Forest Inventory (2003-2007) indicate that mean growing stock volume of all stands comprises 229 m^3 per ha and approximately 7.8 m^3 ha^{-1} of wood is grown annually (Kuliešis et al., 2009). Total volume of the stem wood that is harvested by final and intermediate cuttings (including sanitary) comprises 60% of gross annual increment. Besides, the retention of snags and logs is induced in the forest harvest sites. Therefore, the amount of merchantable dead wood (suitable for fuel) over 5 years had increased by 2.5 m^3 ha^{-1} and on an average contains 9.0 m^3 ha^{-1}.

Our study was performed in Lithuanian commercial and reserve forests. It presents data on: (1) carbon (C) and nitrogen (N) contents in coarse woody debris (CWD) of Norway spruce (*Picea abies* (L.) H. Karst.) and silver birch (*Betula pendula* Roth); (2) C and N contents in mineral topsoil under CWD; (3) comparison of bryophyte diversity and coverage on logs and stumps. The decrease of wood density and C pool was found, while N pool remained steady or increased in very decayed CWD. Only slight increase of C pool was observed in mineral topsoil under CWD. The bryophytes predominate on CWD and in total 62 bryophyte species were recorded on the surface of logs and stumps. Despite some differences it was concluded that the stumps instead of logs partially, but significantly, preserve the diversity of the epixylic bryophytes.

Session: “Biodiversity and Alien Species under Global Pressure”

Spread intensity and invasiveness of sycamore maple (*Acer pseudoplatanus* L.) in Lithuanian forests

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The main objective of the study was to estimate sycamore seedlings abundance, spread intensity and invasiveness in Lithuanian forests. *Acer pseudoplatanus* is a large tree and this alien species was introduced to Lithuania in 1802. Sycamore is being more frequently grown in the parks, but in some places has been planted also in the forest. The species has exceeded the limits of naturalisation and gradually is becoming invasive.

The abundance of undergrowth of varying height and also spread intensity were investigated in six forest blocks, covering the main spread areas in south-western part of Lithuania. The density of sycamore seedlings was evaluated in four height groups. Invasiveness of the species was estimated by applying Pest Plant Prioritization Process, based on the Analytic Hierarchy Process method.

The results show that the average spread distance from the mother tree was 257 meters. Mean number of seedlings per hectare was 2064. Invasiveness degree of sycamore maple was higher than average (0.6426), the present compared to potential distribution was medium intensity rating (0.57), the social, environmental, and economic impacts score was very low (0.1682). Final Pest Plant Score of *A.pseudoplatanus* was lover than medium (0.3537). Based on the obtained estimates we can conclude that sycamore is invasive, spreading abundantly in the places where it was planted. Therefore the use of sycamore for forest plantations should be regarded with care.

Session: “Biodiversity and Alien Species under Global Pressure”

Phytophthora spp. in deciduous trees in Lithuania: preliminary results

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The assessment of alien invasive species of *Phytophthora* genus causing serious forest tree species diseases was carried out in 21 districts of Lithuania. 333 trees from 15 genus and 23 species with typical to *Phytophthora* genus disturbance symptoms in city greeneries, parks, and forests were documented. The highest percentage of disturbed trees was observed among *Acer* (50%) and *Alnus* (19%), while *Tilia* was acknowledged as the most resistant deciduous genus in Lithuania. More than a half of documented trees were young individuals (51%). The young trees typically grow nearby water sources, while the number of premature and mature diseased trees does not correlate with the distance to water source. Small bleeding spots on stem is a typical disturbance symptom of young trees, while large bleeding spots and bark cracks are the common symptoms of premature and mature trees ($p<0.00$). The presence of *Phytophthora* DNA was confirmed using real time PCR analysis on 23 DNA samples. The sampling included wood from diseased trees, leaves from shrubs, leaves baited in water, and soil samples gathered around diseased plants. Extracted DNA from soil and plant tissues was tested for the presence of *Phytophthora*. All analysed samples were positively recognized by *Phytophthora*-specific probe during real time PCR, which proves the presence of pathogens in environmental samples.

Notes

ENVEUROPE

ENVIRONMENTAL QUALITY AND PRESSURES ASSESSMENT ACROSS EUROPE: THE LTER NETWORK AS AN INTEGRATED AND SHARED SYSTEM FOR ECOSYSTEM MONITORING

EnvEurope, proposed within the Component "Environmental Policy and Governance" (EPG - Strategic Approach) of the European Commission Programme LIFE, contributes to the European process SEIS (Shared Environmental Information System) and the initiative GMES (Global Monitoring for Environment and Security), in a context of ecological knowledge transfer from science to environmental policies.

The project, co-funded by EC for 3 M€, will last 4 years (2010-2013) under the Coordination of Italy, Institute of Marine Sciences, National Research Council (CNR-ISMAR).

EnvEurope started and is being developed within the European Long-Term Ecosystem Research Network (LTER-Europe) which represents more than 400 sites across Europe. The long-term (multi-decadal) ecological study and monitoring of ecosystems need shared scientific knowledge, a common information management system and the harmonization of parameters and methods at European scale.

This will bring to a deeper understanding of ecosystem functioning, to an improved environmental management and to supporting the development of EU environmental policy and conservation planning through the integration of objectives, resources and disciplines.

Through six main Actions EnvEurope contributes to the integration and coordination of long-term ecological research and monitoring initiatives at European level. It focuses on understanding the status, changes and trends of ecosystems, with an integrated broad-scale and cross-domain (terrestrial, continental waters or wetlands and marine ecosystems) strategy, combining the efforts of 11 countries and of at least 67 sites belonging to the LTER-Europe network.

EnvEurope selects, on the basis of multi-annual data series and of newly collected field data, a set of key environmental quality indicators able to characterise ecosystems and sensitive to major natural and anthropogenic stressors.

Therefore, it develops and provides an integrated environmental information management system contributing to bridge the gap between science and policy and to improve the scientific support to the EU environmental policy and conservation plans.

INVOLVED COUNTRIES

STEERING COMMITTEE MEMBERS AND ACTION RESPONSIBLES

AUSTRIA MICHAEL MIRTL, JOHANNES PETERSEIL/Environment Agency Austria

BULGARIA SVETLA BRATANOVA-DONCHEVA/Institute of Biodiversity and Ecosystem Research

FINLAND JUHA KARJALAINEN/University of Jyväskylä

GERMANY MARK FRENZEL/Helmholtz Centre for Environmental Research; PETER HAASE/Senckenberg Research Institute and Natural History Museum

HUNGARY MIKLÓS KERTÉSZ/Hungarian Academy of Sciences; ILONA MÉSZÁROS/University of Debrecen

ITALY ALESSANDRA PUGNETTI, MARIANGELA RAVAIOLI, GIORGIO MATTEUCCI, ROBERTO BERTONI /Italian National Research Council; ENRICO POMPEI, FRANCO MASON/National Forest Service of Italy; DANIELA SANI, STEFANO VALENTINI/ASTER

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Project LIFE08 ENV/IT/000399 co-financed by the European Commission Programme LIFE+ (2010-2013)

European Cooperation in Science and Technology

www.cost.esf.org

Action FP0903 2009 - 2013

Climate Change and Forest Mitigation and Adaptation in a Polluted Environment

Participating countries: AT, BE, BA, BG, CZ, HR, DK, EE, FI, FR, DE, GR, IL, IT, LV, LT, NL, NO, PL, PT, RO, RS, SK, SI, ES, SE, CH, TR, UK

FPS

Chair of the Action: Elena PAOLETTI, IT, e.paoletti@ipp.cnr.it

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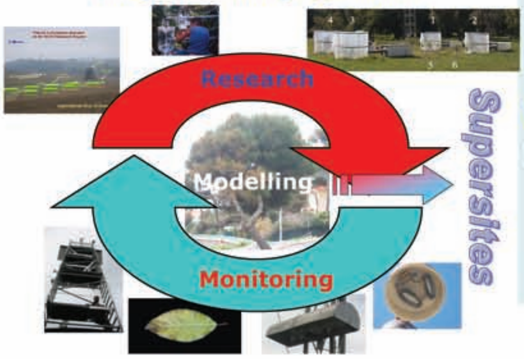
Integration among themes

Integration among approaches



Working Group 1 - Availability and evaluation of monitoring data

A review of current sites and measurements is carried out, along with a comprehensive analysis of present data sets from different European monitoring programs (with special reference to EMEP, ICP Forests, CarboEurope, NitroEurope and the COST Action ES0804 on atmosphere-biosphere fluxes). The main focus is on ozone, nitrogen, carbon sequestration, increased temperature and extreme climatic events..

Working Group 2 – Scientific gaps and modelling

Topical limitations to the present scientific knowledge are addressed. Prospects are prioritised based on their technical feasibility and added value for research and operational communities. This knowledge adds information that is useful for the parameterization of models. An assessment of the present model uncertainties will result in improved outputs of models (with special reference to dynamic modelling of carbon and nitrogen budgets, and ozone flux).

Working Group 3 – Protocols and supersites

Monitoring sites, specific requirements, measurement techniques, instrumentation, maintenance, procedures for calibration, data processing and storage will be standardised, based on the WG1 and WG2 results.

Working Group 4 – Training and transfer of results

As most of the Action work load is due to common activities, the conceptual work is done by WGs 1, 2 and 3, while WG4 leads the practical details of the organization of common events (training courses, conferences, workshops) and the circulation of results of the Action activities (website, newsletter, publications, contacts with policy makers and end users). This work is done in close agreement with the Management Committee and the other WGs.

Main objectives:

- To increase understanding of state and potential of forest mitigation and adaptation to climate change in a polluted environment
- To reconcile process-oriented research, long-term monitoring and applied modelling at comprehensive forest research sites (Supersites)

Secondary objectives:

- to expand the evaluation of the presently available data;
- to identify current knowledge gaps and emerging research needs;
- to optimise the geographical distribution of Supersites and assure coverage of the most relevant ecosystems in Europe;
- to assess the value and ecological meaning of measurements and identify which measurements are a priority;
- to develop criteria and standardized protocols for data acquisition, processing, upscaling and storage;
- to promote and facilitate the use of the results beyond the initial targeted research communities.

Main Achievements:

- **Networking**. The Action networked for the first time representatives of the main networks/institutions working with air pollution, climate change and forests in Europe and got a high number of signatory countries, WG members, participants to the conferences, short-term missions and website contacts.
- **To collate monitoring data bases from different sources**. Data from existing monitoring programmes can be used to answer questions about the impacts of air pollution and climate change on forest ecosystems. However, for full use to be made of the available data, a number of questions need to be answered. The Action collected information about accessibility of these databases; intellectual property rights; possibilities for databases harmonisation; quality assurance/quality control procedures.
- **To identify current knowledge gaps and emerging research needs**. The Action identified the following knowledge gaps and research needs: (i) interaction between changes in air quality (trace gas concentrations) and climatic factors on forest ecosystem response, (ii) significance of biotic processes in system response, (iii) tools for mechanistic and diagnostic understanding and (iv) the need for unifying modelling and empirical research.
- **To develop sites where integrated soil, plant and atmospheric research and monitoring will be carried out (Supersites).** Representatives from major European networks recommended a system of supersites for forest monitoring and research in Europe, based on a small number of highly instrumented "supersites" and a large number of lower intensity monitoring sites. The system needs to be based on existing infrastructures but requires more coordination, harmonisation and a joint medium to long term strategy.

COST is supported by the EU RTD Framework Programme

ESF provides the COST Office through an EC contract

Scientific tours

May 19-20

Pre conference scientific tour

7.00 Departure from the hotel/hostel, 19 May

10.00 Refreshments, snacks at Sena Giria café'.

12.00 – Arrival at Vente Cape

Vente Cape an idiosyncratic recess in Lithuania located in Šilutė district on a peninsula in the eastern side of Curonian Lagoon. More than 50 thousand visitors come each year here to see one of the most important spots of bird migration in the world. In addition, visitors are able to admire beautiful landscape which opens from the top of a unique old lighthouse located there. Visitors are always put in mind that Vente Cape is more a kingdom of birds than of people so they are asked to keep quiet and careful not to disturb the quiet bird life.

www.way2lithuania.com/en/travel-lithuania/vente-cape

Vente cape ornitological station

Founded in 1929 by the initiative of prof. Tadas Ivanauskas. Vente Cape became one of the largest birds concentration points on the migration route White sea - Baltic sea. In some days up to 300 thousand birds cross Vente Cape. Staff of the station ring 60-80 thousand birds per year. Traps in the station are the largest ones in Europe. Since the beginning of ringing, 1.6 million birds have been marked in the station.

http://siluteinfo.lt/index.php/pageid/882

13.30 departure to Mingė village. Lunch.

Mingė, the old etnographical village, situated in the Nemunas delta regional park. The only street in the village is a river and a boat is the only means of transport. There the participants of the pre-conference tour will be served lunch with the main fish course.

15.00 departure on boat from Minge village.

During the trip you will have a chance to admire beautiful landscapes of the amazing nature of Nemunas delta regional park, different bird species and dunes of the Curonian spit National park.

http://en.wikipedia.org/wiki/Ming%C4%97

The Nemunas delta regional park

Scenery of the Nemunas delta, with its two main arms, Atmata and Skirvytė, and the island Rusnė is unique. Water is omnipresent and dominates the landscape: river arms branching out, the big lagoon lake Krokų Lanka and many other small lakes, all interwoven. During the great spring flood, the regional park makes an unforgettable impression. Your eyes wander limitlessly over enormous flooded delta meadows with many rare water birds.

The delta is famous for its large number of rare varieties of breeding birds. It is also an important resting area for migratory birds. In 1993, under the Ramsar Convention, it was added to the list of internationally important marshlands. The purpose of the regional park is to preserve this uniquely diverse and constantly changing ecosystem.

http://siluteinfo.lt/index.php/pageid/742

17.00 arrival to Nida, Curonian Spit National Park

Kuršių nerija, the Curonian Spit, is a narrow strip of sand stretching 97 kilometres along the Baltic Sea. According to the legend, the spit was formed a long time ago by Neringa, a girl giant who poured the sandy peninsula into the Baltic Sea to protect the peaceful bay from the stormy sea and create an embankment for fishermen to live. Thus, today the eastern shores of the Curonian Spit are washed by the Curonian Lagoon, while the Baltic Sea washes the western ones. *http://www.visitneringa.com/en*

In 2000, the Curonian Spit cultural landscape was added to the UNESCO World Heritage List. Human habitation on this sand dune peninsula dates back to prehistoric times. Throughout this period it has been exposed to the natural hazards caused by wind and waves. Its survival to the present days has been made possible only as a result of ceaseless human efforts to combat the erosion of the Spit, dramatically illustrated by the continuing stabilization and reforestation projects.

A walk on foot from the harbour down to Jurate hotel on the way sightseeing the old part of town and most famous places.

18.15 guided bus tour to the Sundial on Parnidis dune and Lighthouse on the Hill Of Urbas Sundial (Nida)

The Sundial was built March 11, 1995. From the astronomical point of view the Parnidis dune is an ideal and unique place for the Sundial where an absolute mathematical horizon opens.

http://www.visitneringa.com/en/main/places?id=43485

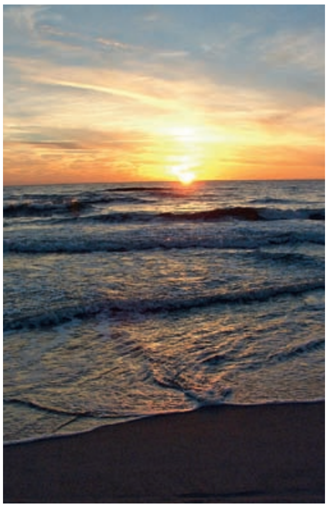
Lighthouse On The Hill Of Urbas (Nida)

This is one of the largest lighthouses on Lithuanian seacoast. A 27 meter high lighthouse of red bricks was built in 1874. The cobble-stone path of 200 stairs leads to the lighthouse.

http://www.visitneringa.com/en/main/places?id=43489

20.00 watching the sunset on the Baltic seaside.

22.00 Dinner under personal request (Curshis café)



20 May 2012.

Departure from the hotel Jurate at 8.00 a.m. to Ethnographic Cementery And Christenings (Nida) (upon request)

Ethnographic cemetery of XIX – XX c. is close to Nida Evangelic Lutheran Church. The wooden tomb monuments of unique shape, typical for the Curonian Spit, called christenings ("krikštai") have remained until now. Christenings – the oldest forms of the tombstones in Lithuania were made of thick and trimmed boards.....

http://www.visitneringa.com/en/main/places?id=43483

9.00 Scientific session – Pinus mugo needs, reality, challenges, and perspectives.

Presentations of local foresters covering the history of Pinus mugo planting and recent prolems.

Pinus mugo (Turra) on Curonian Spit National Park

Pinus mugo (Turra) is an exotic forest tree species introduced to the Lithuanian sea - cost spit of Kuršiu Nerija (Curonian spit, further abbreviated as Nerija) in 1820 to prevent sand erosion by establishing the forest cover.

P. mugo is native to the mountains of central and southern Europe and is a highly morphologically variable species exhibiting a complex taxonomy with an alternative nomenclature (review by Hamernık and Musil 2007). High variation in morphology, adaptation to

specific adaptive environments and high within-taxon hybridization rates makes the taxonomic subdivision complex and difficult. We use the *sensu lato* taxonomic approach suggested by Christensen (1987): one species *P. mugo* has three subspecies: *Pinus mugo* Turra subsp. *mugo*, *Pinus mugo* subsp. *uncinata* (Ramond) Domin and the nothosubspecies *Pinus mugo* nothosubsp. x *rotundata* (Link) Janch. and H. Neumayer (a hybrid taxon between *P. mugo* subs. *unicinata* x *P. mugo* subs. *mugo*). *Pinus mugo* subsp. *uncinata* usually grows as a monocormic tree reaching the height of 14-20 meters with asymmetrical cones having hooked apophysis and is native to subalpine zone and is more common in the western part of the species range (Iberian peninsula; Hamernık and Musil 2007). A hypothesis was raised that *P. mugo* subsp. *uncinata* may share genome with *P. sylvestris* in its evolutionary past (Christensen 1987; Hamernık and Musil 2007). P. *mugo* subsp. *mugo* is polycormic shrub up to 1.5 (2) meter tall with prostrate growth, symmetrical cones with flat apophasis and is spread in the mountains of central and eastern part of the species range. *P. mugo* subsp. *rotundata* possesses an intermediate morphology between subspecies *uncinata* and *mugo* and could be mono- and- polycormic tree reaching the height of 6-7 m. Originally, the subs. *rotundata* is common in peat bogs at the central part of the range.

Left. *P. mugo* subsp. *uncinata* or putative *P. mugo x sylvestris* hybrid (front) on the sea side near Juodkrante. Note the fresh green needle color in contrast to P. sylvestris in the background. Right. *P. mugo subsp*. *rotundata* at Avino Ragas dune near Juodkrantė.

In 1768, professor Johan Daniel Titius from University of Wittenberg in Demark was the first person to suggest afforesting sand dunes with conifer forests in Denmark. Following the professor's initiative, *P. mugo* subsp. *mugo* was introduced in 1798 and *P. mugo* subsp. *uncinata* in 1886 to afforest sandy dunes in the north western part of Denmark (Jørgensen 2006 and references therein). *P. mugo* was introduced to Lithuanian sea-cost spit of Kursiu Nerija since 1825 (at that time a part of the state of Eastern Prussia), after seven villages were destroyed by moving sands. A huge effort by the people of Eastern Prussia was made to prevent stand erosion by building a sea-side dune over all 100 km length of Kursiu Nerija, establishing a grass cover and later planting trees. A forest manager of Neringa Georg David Kuwert in cooperation with a Danish environmentalist Bjorn Sorensen initiated an afforestation programme with *P. mugo* starting at the southern part of Neringa spit. Since then *P. mugo* has been planted on the sea-side dunes, where it fit well and naturalized. In 1904 a large-scale afforestation programme was completed with 2/3 of dunes covered with forests and the eroding dunes were stabilized.

P. mugo x pseudopumillio a polycormic prostrate shrub in the Naglis reserve area

P. mugo subsp. *rotundata* and subs. *mugo* (or their hybrids) prevail in Kursiu Nerija and form a dense cover mainly on the main sea-side dune. Single individuals of *P. mugo* subs. *uncinata* and *P. mugo* subs. *x pseudopumillio* (putative hybrid subs. mugo x subsp. *rotundata*) are also common. At present, most of the *P. mugo* stands reached their natural maturity (raising fire hazard) and variable options were presented regarding its future. Several large-scale spontaneous fire events destroyed a large area of *P. mugo* stands. Recently, genetic studies have been carried out on the problem of spontaneous hybridization between exotic *P. mugo* and local *P. sylvestris* in Curonian Spit and on the genetic variation of P. mugo by the aid of cpDNA markers to create a genetic basis for its gene conservation program. From the theoretical point of view, it may provide an important knowledge for studies of species divergence and speciation with the material introduced over 200 years ago.

Prepared by *prof. dr. Darius Danusevičius, Faculty of Forest and Ecology, ASU*

10.00 Scientific session on Preila EMEP station.

Long term research on air concentrations of the acidifying species and surface ozone.

Air pollution and deposition

Air samples were collected for a 24-h period using 2-stage filter-pack. The first filter in the air stream is an aerosol filter for collecting the airborne particles. This is followed by an alkaline impregnated Whatman 40 filter to collect SO_2. NO_2 has been collected on the sodium iodide impregnated glass sinter filter. The flow rate was 0.5 l/min. The nitrite formed on the glass filter after extraction was determined photometrically.

Weekly precipitation samples were collected in a polyethylene bulk-collector from December to March (snow collector) and in an automatic wet-only sampler during the remaining months. All samples were stored at 4°C until laboratory analysis.

Ion chromatography using Dionex 2010i with conductivity detection was used for the chemical analysis of anions in precipitation and in water extracts from the impregnated Whatman 40 filters. The NH_4^+ concentration in precipitation as well as in the solutions extracted from Whatman 40 filters impregnated with oxalic acid was analysed spectrophotometrically, using the indophenol blue method.

Ozone concentrations were measured continuously using commercial UV-absorption ozone monitor O_3 41 M (Environnement S.A., France) with an air inlet at the height of 2.5 m above ground. Hourly ozone values, their annual average and averages over the warm and cold periods were used in the analysis. AOT40 values, which define the potential risk of O_3 for vegetation (Fuhrer et al. 1997), due to the lack of data, were computed only since 1989.

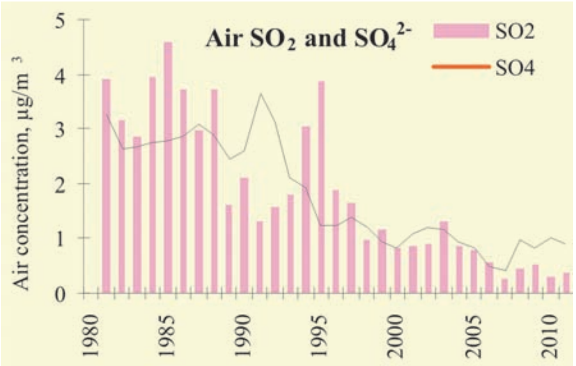
The measurements and analytical procedures were based on a quality assurance/quality control (QA/QC) programme as described in the EMEP CCC manual for sampling, chemical analysis, and quality assessment (EMEP 1977).

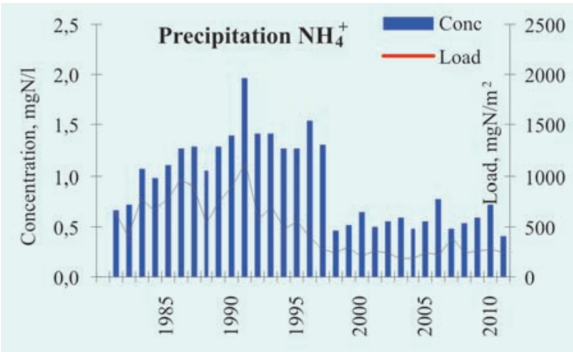
Acidifying species, deposition, their changes and effect on beech tree radial increment.

Data from Preila EMEP station showed a significant decrease in concentrations of the main acidifying species in air as well as in precipitation until the year 2000.

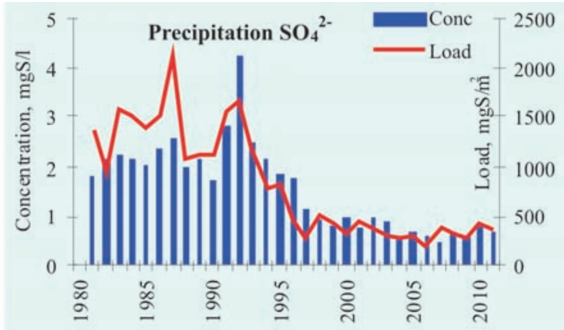
Over this period air concentrations of both S compounds (SO_2 and SO_4^{2-}) decreased by approximately 75-80% (SO_2 from 4.0 to 0.85 µgS/m^3 and SO_4^{2-} from 3.0 to 0.83µgS/m^3). Sulphur concentration in precipitation and its wet deposition decreased by 70% and 85 %, respectively, i.e. concentration in precipitation from 2.5 mg/l to 0.8 mg/l and in wet deposition from 2100 mg/m^2 to 310 mg/m^2 (Fig. 5). This significant decrease ($p<0.05$) in annual air concentrations and deposition of the sulphur compounds was most likely the result of a reduction in SO_2 emissions in Europe including Lithuania (CLRTAP 2005).

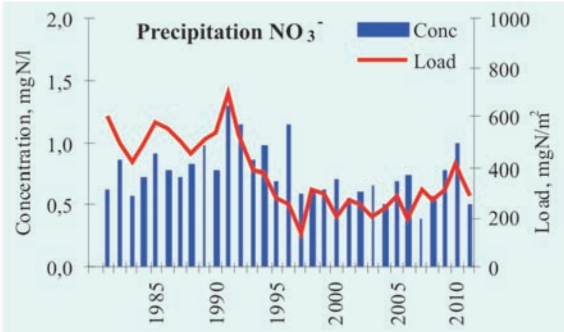
Highest concentration of ammonia in precipitation and level of its wet deposition was reached in the period between 1987-1993 (1992 NH_4^+ 2.0 mgN/l and 1120 mgN/m^2). Afterwards, pollution level by this species decreased significantly up to 0.6 mgN/l and 200 mgN/m^2 in 2000, what made 70% and 82% respectively.



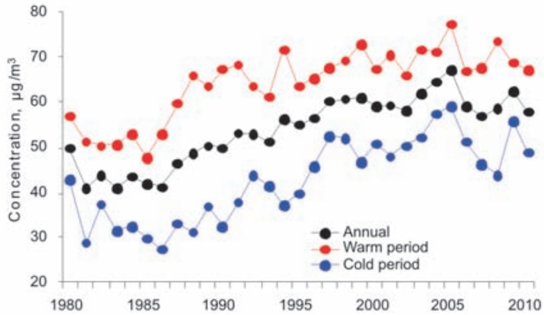


Changes in NO_3^- deposition were least expressed, although some decrease in wet concentration and wet deposition was detected. Until 2000 NO_3^- concentration in precipitation decreased by 53% (from 1.3 mgN/l to 0.6 mgN/l) and wet deposition by 72% (from 700 mgN/m^2 to 200 mgN/m^2).

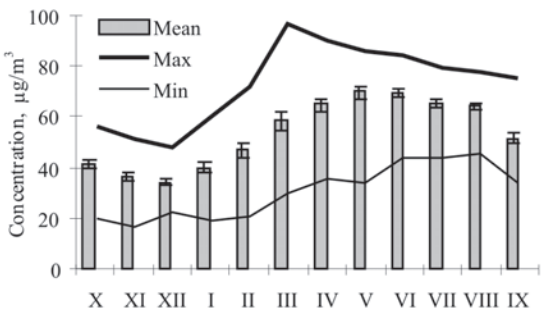




Between 2000 and 2007 a further decrease in SO_2 and aerosol SO_4^{2-} air concentrations up to 0.26 µgS/m^3 and 0.40 µgS/m^3 respectively, was observed. Those were the least values of these acidifying species over the entire observation period. Afterwards, a gradual increase in air concentrations of these sulphur species started and in the last 2010 year these values increased up to 0.31 µgS/m^3 and 1.02 µgS/m^3 respectively. In SO_4^{2-} wet concentrations and deposition data series the same tendencies of variation were detected. The least values of SO_4^{2-} concentration in precipitation during the 2000-2010 period were detected in 2007, when it reached 0.46 mg/l, and in wet deposition in 2006 when it reached 178 mg/m^2. In the last 2010 year these values increased again up to 0.8 mg/l and 420 mg/m^2.

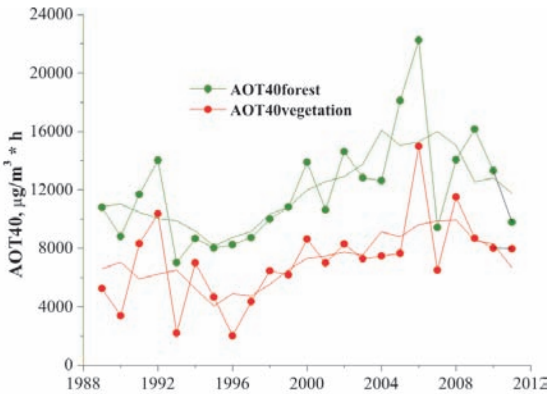


Since 2000 NH_4^+ deposition and its concentration in precipitation, contrary to sulphur concentration, started increasing gradually by 6.8 mg/m^2 per year ($p>0.05$) and 0.014 mg/l per year. In 2010 their values exceeded 0.7 mg/l and 260 mg/m^2 respectively. Increase in NO_3^- deposition and its concentration in precipitation was two times higher and made 12.8 mg/m^2 and 0.027 mg/l per year. In 2010 NO_3^- concentration in precipitation exceeded 1.0 mg/l and in deposition 400 mg/m^2 respectively.



The annual mean ozone concentrations show an increasing trend (1.13 µg/m3, $p<0.001$) during the period 1981-2006 period. The increasing trend was also during warm (1.01 µg/m3, $p<0.001$) and cold (1.0 µg/m3, $p<0.01$) periods as well. After 2006 year the decrease of the ozone concentration is observing.

Data on AOT40 showed a substantial temporal variation. Exceedance of the critical level for the protection of the forest trees was not observed un till 1997 year, but later this level was considerably exceeded or almost reached. The last five years 2007-2011 can be characterized as a period with low ozone level and, herewith, with low AOT40 values.



Prepared by *dr. Dalia Jasinevičienė and Raselė Girgždienė, Physic institute*

11.00 Nature Rezerve Nagliai

Cognitive path in the Nature Reserve near Pervalka

The Nagliai Nature Reserve occupies an area of 1680 hectares. It extends for the distance of 9 kilometres from Juodkrantė to Pervalka. Here you can see the so called Grey Dunes, otherwise known as the Dead Dunes, spontaneous wild-growing forest vegetation and centennial wood soils buried underneath the sand.

Due to strong winds impressive ravines, erosions and washouts are formed in these dunes. Here and there, fragments of old soils appear from under the sands.

The sightseeing path is 1100 m. Half of that distance is covered with gravel, the rest is sand.

http://www.visitneringa.com/en/main/places?id=58949

12.30 Herons and cormorants colony near Juodkrantė

Scientific session: Effect of huge amount of ammonia on forest ecosystem, health of trees, plant biodiversity, epiphitic lichens, soil chemistry in overmatured pine stands.

Just outside Juodkrantė is a colony of herons and cormorants. Data for the year 2000 indicates that 582 gray heron and 1361 cormorant pairs nested here.

Cormorants (*Phalacrocorax carbo* L. Carbo or CORMORANO), appeared in Juodkrantė in 1803. Until 1978, great cormorants were rare guests to Lithuanian coast and the Curonian Lagoon. Subsequently, only single birds were spotted in these areas from time to time, mostly in spring and autumn migration periods.

First cormorants began nesting in 1989. Now side by side there are two - the heron and cormorant colonies. The consequences of their competition are still to be seen. Now herons and cormorants are being protected by law, so the artificial reduction of their numbers is out of question.

http://www.visitneringa.com/en/main/places?id=43560

In 2010 cormorant nests exceeded 3300. What does it mean? It is approximately 7000 adult birds every of which needs 100-180 g fish per day (an adult bird can consume up to 0.75 kg of fish per day!!!). They come back to their nest places at the end of March and leave the CSNP in October. At least 6 months – 180 days, 100 g fish per day – total 126 t fish per season. In addition the population increases by 3-5 broods, therefore at least 3 months (approximately 100 days) 10000 birds (3500 nests and 3 broods in each) need at least 100 t fish. Total losses in fish resources make 226 t fish per season if birds catch only 100 g fish per day.

Please calculate for yourselves if they need fewfold more!

Fishermen are against the cormorants. Biologists state – everybody has a right to survive. Where is the solution of this problem?

15.00 – 16.00 Scientific session: Burned Pinus mugo stands. Invasion of alien tree species. Effect of meteorological condition on forest recovery.



What happened after the mountain pine fire? Pine diseases came from North America! Invasion of the alien tree species – Robinia pseudoacacia – in the damaged area.


Wooden Sculptures Exposition at the Hill of Witches
(upon personal request)

One of the most beautiful and oldest parabolic dunes in Juodkrante is a Hill of Witches. The slopes of the hill are overgrown with centuries-old pine trees, the meander leads through the shady woods to a 42–meter- high top. From there opens a view of beaming sea, through the pine and fir trunks the lagoon shines.

http://www.visitneringa.com/en/main/places?id=43492

19.00 Ice breaking party at the café at Park Inn Hotel.

21.00 Arrival to the hostel at Campus.

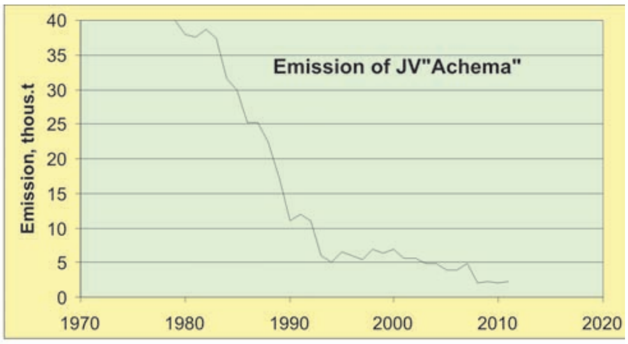
Scientific Trip 23 May 8:00 – 12:00

Nitrogen fertilizer plant SC 'ACHEMA'

Achema is a leading manufacturer of nitrogen fertilizers and chemical products in Lithuania. It was established in 1965 and was gradually expanding till 1978, when the most polluting Nitrophosca department was constructed, and total annual emissions reached 40 thou. t. In the 1980s the annual deposition of sulphur and nitrogen was very high. Near the factory annual deposition of S reached 150 kg ha^{-1} and annual deposition of N was 121 kg ha^{-1}. Along the prevailing wind transect concentrations of S and N were decreasing 5-6 fold

Pine *(Pinus sylvestris* L.) forests prevail in this region. The first signs of local forest damage were observed in 1972. After a very hard winter in 1979, obvious signs of forest damage in the direction of prevailing winds were recorded up to 10–12 km, and at a distance of 2–3 km from the pollution source coniferous forests were completely dead.

After this accident the Nitrophosca department was closed, new technologies were implemented. Productivity decrease and substitution of oil by gas resulted in nearly 8-fold decrease in the emissions.



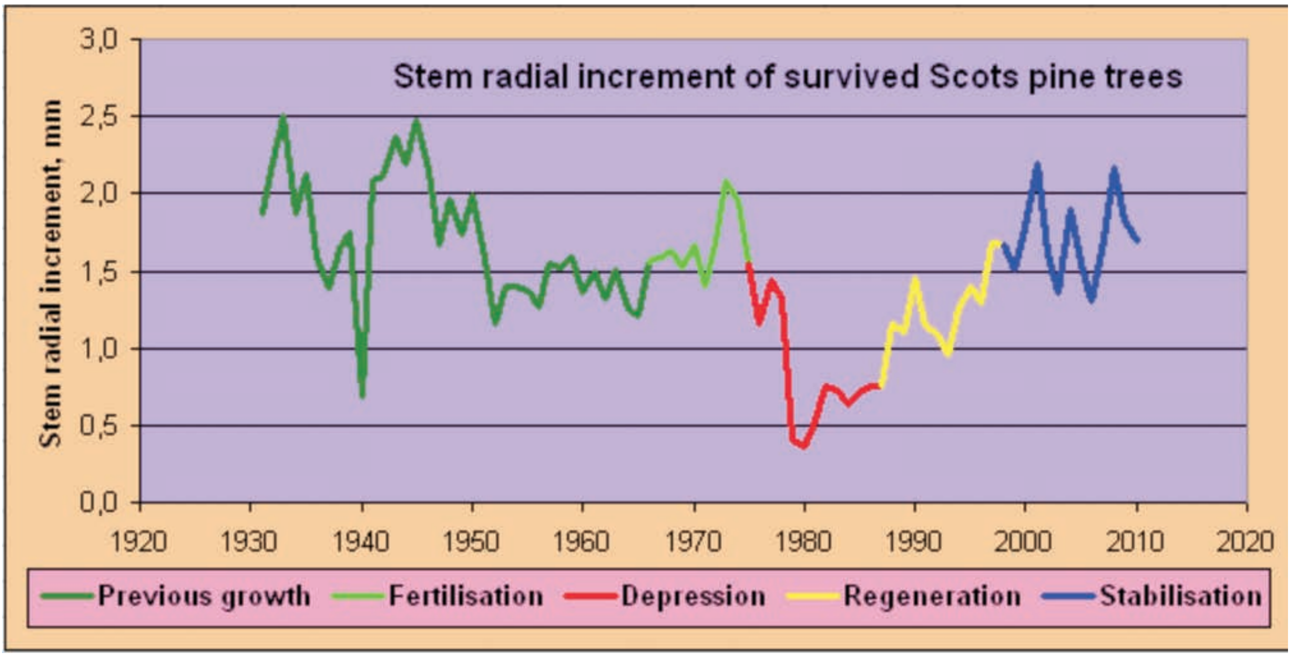
Now the total emission makes only 2-3 thous.t.

The composition of emissions changed during this period significantly. In 1979, when the total amount of annual emissions was 37 thou. tons, carbon monoxide made 26.5%, sulphur dioxide – 12.4%, nitrogen oxides - 10.3%, ammonia – 10.1% and mineral dust- 37.3%. In 1997 the input of carbon monoxide in the emissions was

approximately 66.0%. The input of other pollutants has decreased essentially and made: sulphur dioxide 9.7%, nitrogen oxides – 7.6%, ammonia – 11.3% and mineral dust – 2.4%. As a result such an essential decrease in 'Achema' emissions, annual total load of sulphur (wet and dry) decreased almost tenfold close to the plant and approximately threefold at a distance of 10–20 km in the direction of prevailing winds. The decrease in total nitrogen load was less essential, i.e. 4-5-fold at a distance of 0–5 km, and approximately two-fold at a distance of 10–20 km.

The implementation of modern technologies resulted not only in the reduction of the emissions but also in the improvement of health of the people living in Jonava and the surrounding regions. In 2000 Company implemented Environmental management system in compliance with the requirements of ISO 14001. After such considerable abatement of environmental pollution, the obvious signs of forest recovery in the surroundings of 'Achema' were registered.

No defoliation threshold was determined beyond which the recovery of the survived trees becomes impossible.



Now earlier damaged Scots pine trees growth more intensive and formed the wider annual tree rings even than before the beginning of plant activity 1950-1965.

25 May, 2012

Post-conference tour

7.00 Departure from the hotel/hostel

8.00 Arrival to Trakai History national park

The Trakai Historical National Park is close to the city of Vilnius, in Trakai and is the smallest among five national parks of Lithuania.

The Trakai Historical National Park was established in the year 1991 by the Lithuanian Restoration Seimas. The park has a total area of 9200 hectares and around 32 lakes that occupy a total area of around 1400 hectares.

Trakai used to be a historical capital of Lithuania and is otherwise known as the 'town of lakes'. Trakai town owns a unique castle which is the only of its type in the entire Eastern Europe. The castle is surrounded by waters of the Lake Galvė on all four sides and is called the Trakai Island Castle. Though constructed in 1410 just after the famous Battle of Grünenwald as a defense fortress, it was turned into a residence of Grand Dukes of Lithuania Vytautas and Kęstutis. It was meant to be a fortress and it was never conquered by any raiders.

http://www.way2lithuania.com/en/travel-lithuania/trakai-historical-national-park

9.30 – 10.00 Karaim national food - kybyn at the Restaurant Kybynlar.

The appearance of the Karaims in Lithuania and the name of Vytautas the Grand Duke of Lithuania are in a close relation. It is unclear where in the Black Sea region Vytautas could encounter the Karaims. During that time, there occurred three battles between the Lithuanian army and the Tatars: the first one, in the year of 1397, in the lands of the Azov Horde, and the second and third ones, in the year of 1398, near Kaffa (now Feodosia) and Solkhat (now Staryj Krym).Vytautas brought the Karaims (several hundred of families) home as warriors and honest servants. They were settled between the two castles of the Ruler in Trakai, and in other locations near the Lithuanian border: Biržai, Pasvalys, Pušalotas, Naujamiestis, Panevėžys. Vytautas and other rulers of Lithuania expressed their confidence to the Karaims by affording the privileges to the Karaim communities. The Karaims were loyal to the Lithuanian rulers, protected their castles, practiced medicine, and worked as translators.

http://www.karaim.eu/index.php?id=24&lang=en

10.00 departure to Aukstaitija NP, Aukstaitija Integrated Monitoring Station

11.30 – 13.00 Aukstaitija Integrated monitoring station

Scientific session at the station.

Results obtained on long range transboundary air pollution, acid deposition, their transformation under rapidly changing climate conditions and integrated effect on forest ecosystem.

19 year experience in the field of forest sustainability under the global changes.

13.00-14.00 Lunch.

14.00 – 16.30 Scientific session at IMS

17.00 – departure to the most famous places of Aukstaitija NP.

Aukštaitija is a region of hills, lakes and forests. The Aukštaitija National Park was approved as one in 1974. The main purpose of establishing of this park was to preserve cultural and natural heritage of Aukštaitija region which distinguishes in unique ethnography and also to spread an idea of eco-awareness.

http://www.way2lithuania.com/en/travel-lithuania/aukstaitija-national-park

Places to visit

There are 6 old watermills in Aukštaitija National Park. The most famous of them is 200 year old Ginučiai watermill. Inside the mill there is a unique equipment preserved.

There are also a few places worth visiting – Ladakalnis and the Ginučiai castle mount.

One of the examples is a wooden church in Palūšė which is a monument of wooden architecture in Lithuania.

Perhaps the most interesting museum in the Aukštaitija National Park is the museum of Beekeeping. Also, entire ethnographic villages scattered around the territory of Aukštaitija National Park are all as open air museums.

20.00 Arrival at Molėtai Astronomical Obser vatory

The Molėtai Astronomical Observatory was built in Molėtai region in 1969. It is well known that watching astronomical objects requires darkness and clear sky so the new and pretty better place for the astronomical center was chosen. The Molėtai Astronomical Observatory was erected 70km north from Vilnius on the Kaldiniai hill.

The observatory belonging to the Institute of Theoretical Physics and Astronomy is not only the main observing place for visitors, scintists, but also for astronomers as there is a wide range of observing technologies held in the Observatory. There is a 35/51 cm Maskutov telescope available, 63 cm reflector and the largest in North Europe telescope of 165 cm.

A three-channel photoelectric photometer and a Coravel-type radial spectrometer are used for astronomic researches. Lithuanian astronomers participate in many international astronomic projects like photometry of stars in galaxy and star clusters, studying galaxy population, developing methods

of temperatures, luminosities, peculiarity star types determination. Lithuanian astronomers cooperate with the partners from Denmark and the USA.

Everybody is pleased to get acquainted with the great number of exhibits including real telescopes, many original impressive galaxy photos, the latest astronomy news. Sometimes visitors can get a chance to glance to the sky through the telescope and to see the cosmos by themselves! On the southern wall of the Molėtai Astronomical Observatory a real sun clock is located, not far from the telescope tower a collection of mythological stones is exposed. Also an eye-catching stained-glasses decorate windows of Observatory. Finally, next to Kaldiniai hill is another hill where the Museum of Ethnocosmology is located where visitors are able to get acquainted with the historical viewpoint about celestial bodies.

http://www.way2lithuania.com/en/travel-lithuania/moletai-astronomical-observatory

The final accents of the conference.

22.00 Departure to Kaunas

24.00 Arrival to the hotel/hostel. Farewell and see you in Brazil in 2013.

Scientific Session at Aukštaitija IMS (integrated monitoring station)

International Cooperative Programme (ICP) on Integrated Monitoring of Air Pollution Effects on Ecosystems

The integrated monitoring of ecosystems refers to the simultaneous measurement of physical, chemical and biological properties of an ecosystem over time and across compartments at the same location. In practice, monitoring is divided into a number of compartmental subprogrammes which are linked by the use of the same parameters (cross-media flux approach) and/or same/close stations (cause-effect approach).

ICP Integrated Monitoring

The multi-disciplinary Integrated Monitoring programme (ICP IM) is part of the effect-oriented activities under the 1979 Convention on Long-range Transboundary Air Pollution (LRTAP), which covers the region of the United Nations Economic Commission for Europe (UNECE). It belongs to a group of six specialist International Cooperative Programmes (ICPs) which have been set up under the LRTAP Convention's Working Group on Effects to look at relevant receptors and environmental issues. The ICP IM sites are catchments/plots located in natural or semi-natural areas.

Aims of ICP Integrated Monitoring

The overall aim of integrated monitoring was originally to determine and predict the state and change of terrestrial and freshwater ecosystems in a long-term perspective with respect to the impact of air pollutants, especially nitrogen and sulphur. This was to provide one basis for decisions on emission controls and assessment of the ecological impact of such controls within Convention on Long-range Transboundary Air Pollution of the UNECE. However the full implementation of the Integrated Monitoring Programme will allow the ecological effects of tropospheric ozone, heavy metals and persistent organic substances to be determined. Implementation of the Programme will provide a major contribution to the international data requirements for examining the ecosystem impacts of climatic change, changes in biodiversity and depletion of stratospheric ozone. A primary concern is the provision of scientific and statistically reliable data that can be used in modelling and decision making. The main emphasis is to establish consistent time series for environmental variables rather than establishing representative surveys across the UNECE region.

The aims are fulfilled by:

- monitoring both biogeochemical trends and biological responses in small (10 - 1000 ha) clearly defined areas
- seeking to separate the noise of natural variation, including succession, from the signal of anthropogenic disturbance by monitoring natural or semi-natural ecosystems
- developing and applying tools, e.g. models, for regional assessment and prediction of long-term effects.

The following fifteen countries have continued data submission to the ICP IM data base during the period 2006 - 2010: Austria, Belarus, Canada, Czech Republic, Estonia, Finland, Germany, Italy, Latvia, Lithuania, Norway, Russian Federation, Spain, Sweden, and United Kingdom.

Integrated monitoring data are at present submitted from 43 sites. Additional earlier reported data are available from sites, which have either been suspended or taken out of the IM network and used for regional monitoring.

http://www.environment.fi/default.asp?node=6318&lan=en

The Integrated Monitoring Programme at Aukštaitijs IMS

As the initiative of Nordic Council of Ministers, the seminar for environmental specialists from Nordic and Baltic countries was organised in Tallinn on July 30th of 1992, where the memorandum was signed and preliminary suggestions for implementation of integrated forest monitoring stations in the Baltic countries were formulated. In the next 1993 year Aukstaitija Integrated monitoring station (LT-01) was founded at the branch of Forest monitoring Laboratory of former Lithuanian University of Agriculture present Aleksandras Stulginskis University and IMS closed basin in strict reserve zone of Aukstaitija national park in Ažvinčių over matured forest, Versminis river. The area of the basin is 101.5 ha. The lowest place is 159.5 m, the highest - 188.6 m above the sea level.

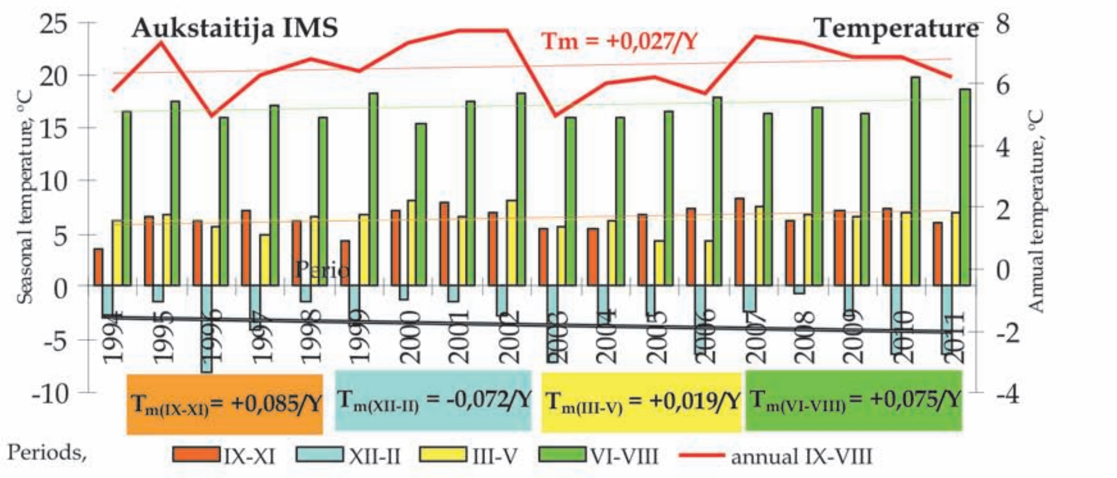
Glacioaquatic accumulation forms with sand, gravel and stones are typical of Aukstaitija IMS (LT-01) catchment which with the decrease of altitude transfers into fliuvioglacial terrace delta plain with fine sand, and at the source- into marsh accumulation forms with organic sediments. Multi-aged and multi-layered mature and over mature pine and spruce stands on haplic arenosol, which at lower places transfers into albic as well as gleyic arenosol and histosol (eutrophic deep peat soil) prevail in the catchment.

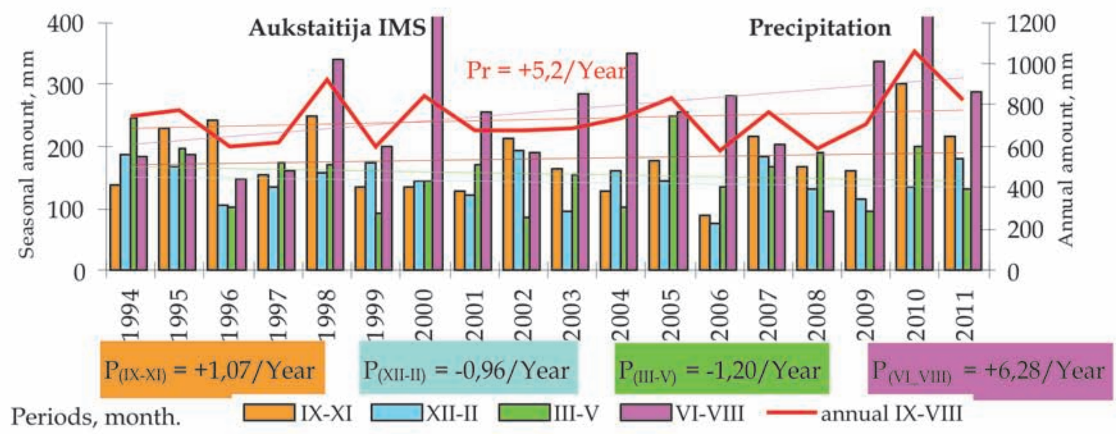
The Integrated Monitoring Programme, which has been performed for almost 20 years in Lithuania, provides all the necessary data to detect main tendencies in variation of meteorological parameters, air concentrations of acidifying species and their deposition, heavy metals, and ozone as well as soil mediated parameters and to establish which effects – direct, through the impact on leaves and needles or indirect, through the changes in soil mineralization and eutrophication processes – might be more significant to changes in forest biota in general and crown defoliation and tree increment of the prevailing tree species in Lithuania partially, and which of them constitute a greater threat in their integrated impact.

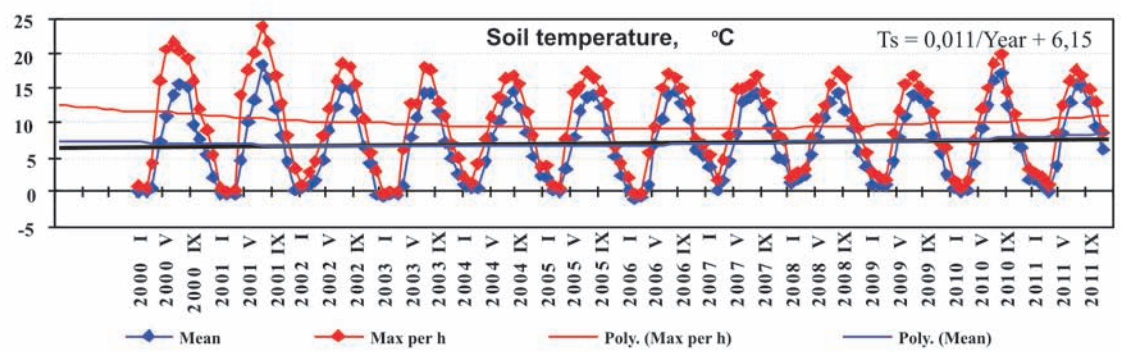
Climatic condition:

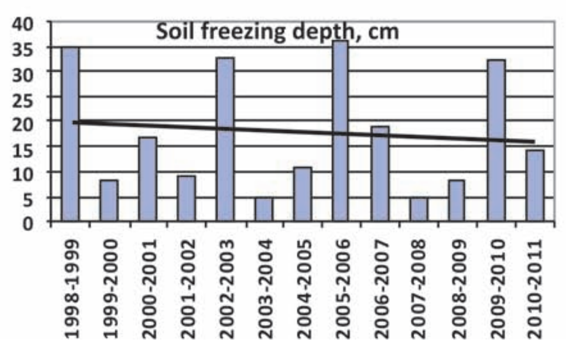
Climate in Aukstaitija IMS is characterised as average cold with high humidity and abundant precipitation. Mean annual precipitation in Aukstaitija NP over the last 20yr period was 612 mm and did not demonstrate significant trends (increase by 5 mm per year, $p>0.05$). Most intensive increase occurred over the vegetation period – by almost 5 mm per year, meanwhile over the dormant period no tendencies in precipitation amount were detected. Despite these changes, between 2005 and 2010 when pine crown defoliation demonstrated a tendency towards increasing, precipitation amount over the vegetation period started decreasing by almost 30 mm per year and only in 2010 increased significantly exceeding long term annual average by almost 260mm, i.e. amount over vegetation period increased by 140 mm and dormant period – by 120 mm.

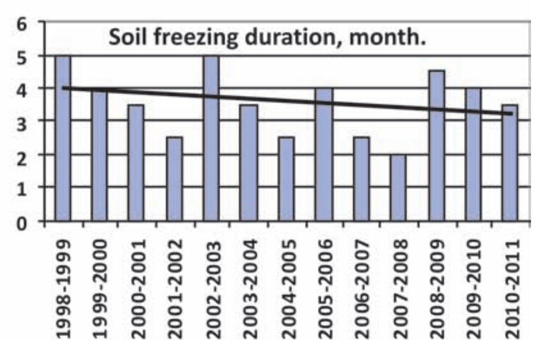
Mean annual temperature for the long term period made +6.4°C and tended to increase between 1991 and 2011 by 0.037°C per year. This increase was in full agreement with the data presented by the SRES A1 B Project (3.5°C per 100 years), and was most pronounced in the first half of the dormant period (September–November) when it made 0.12°C per year. From December to February mean monthly temperature showed a tendency towards decreasing by -0.09 per year while over the months of spring (March-May) and summer (June-August) towards increasing by +0.03°C and +0.06°C per year. Generalized data on air temperature revealed trends towards increasing over both (vegetation and dormant) periods, which were expressed by 0.06°C and 0.01°C per year, respectively.



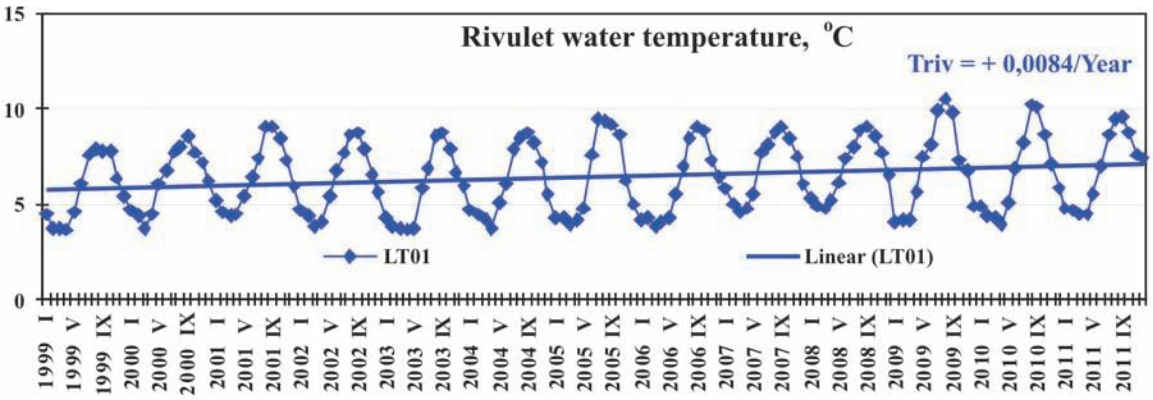


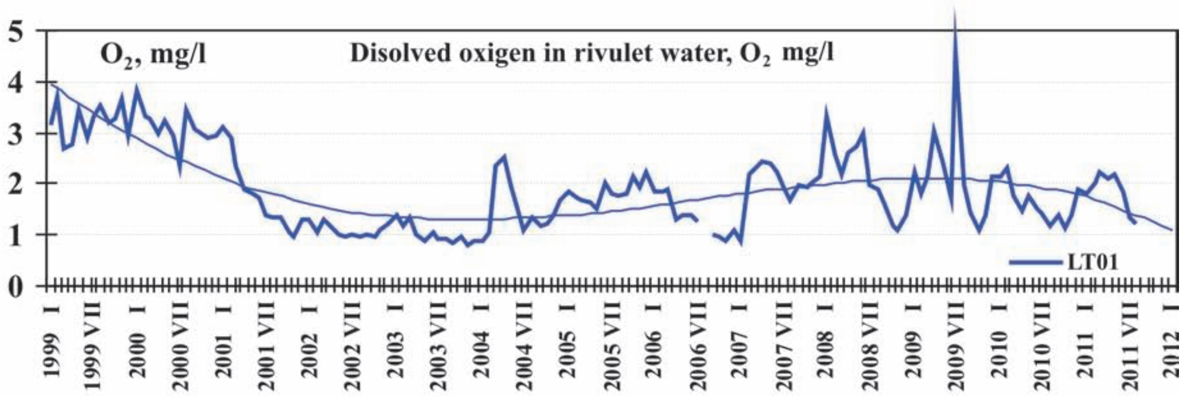


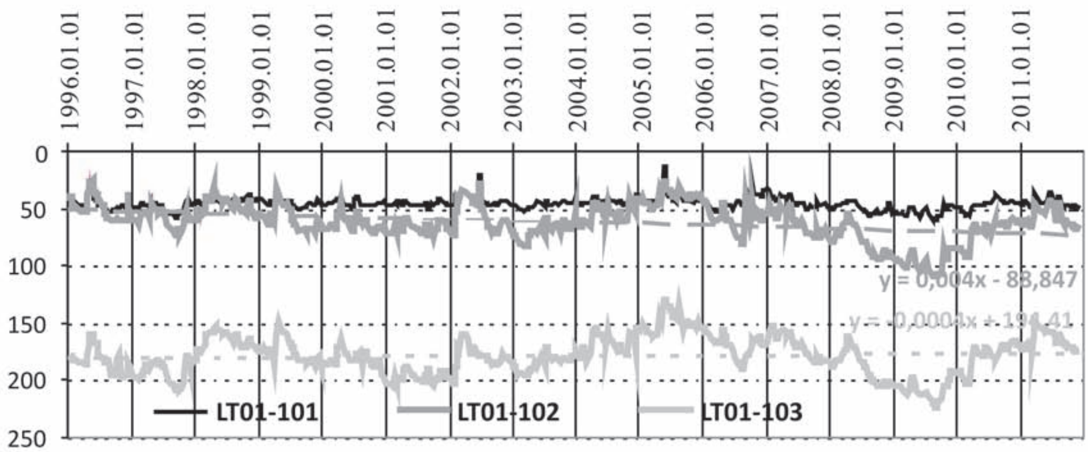


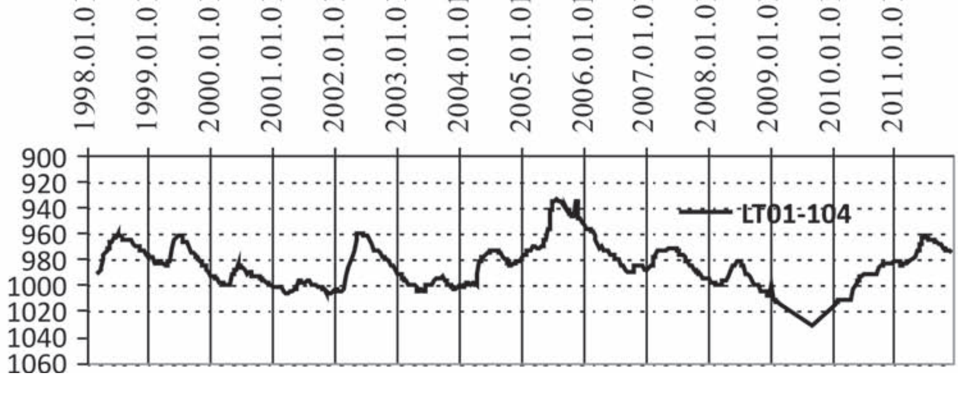


Changes in mean temperature of soils demonstrated tendencies similar to those in air temperature.









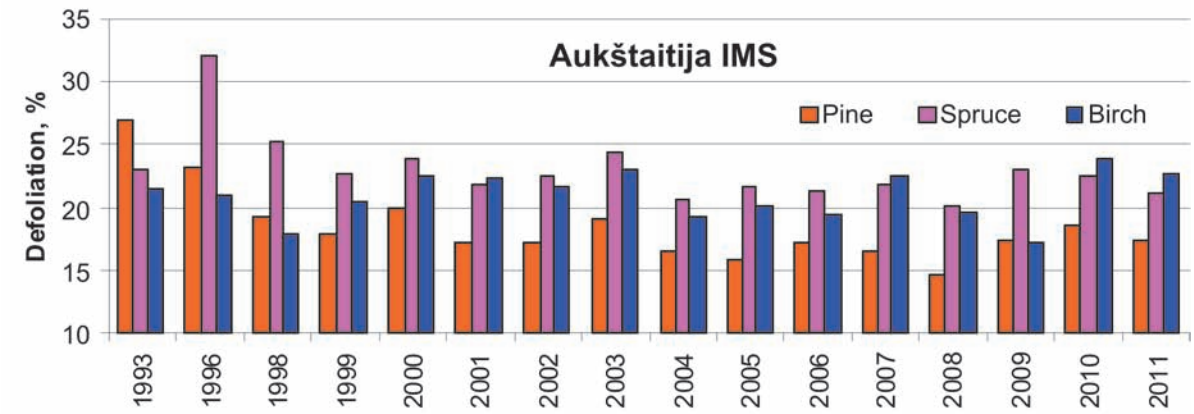
Changes in ground water at four different levels (101-104)

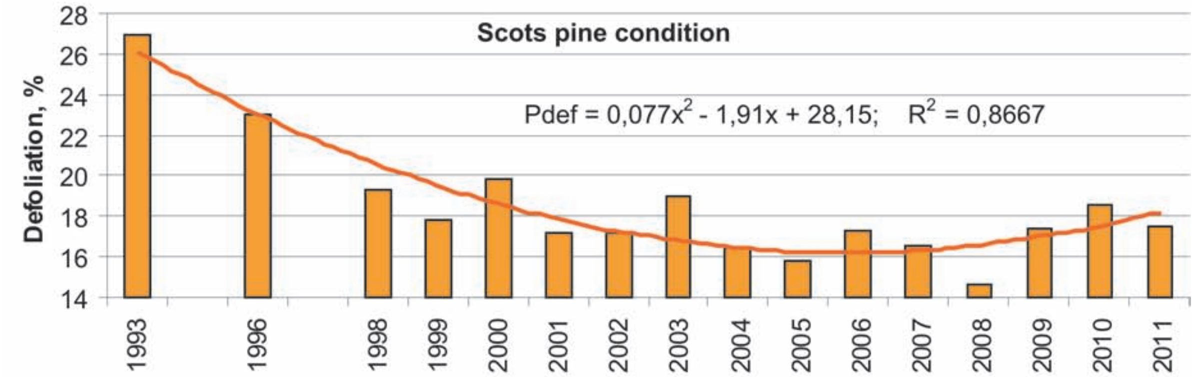
Forest health:

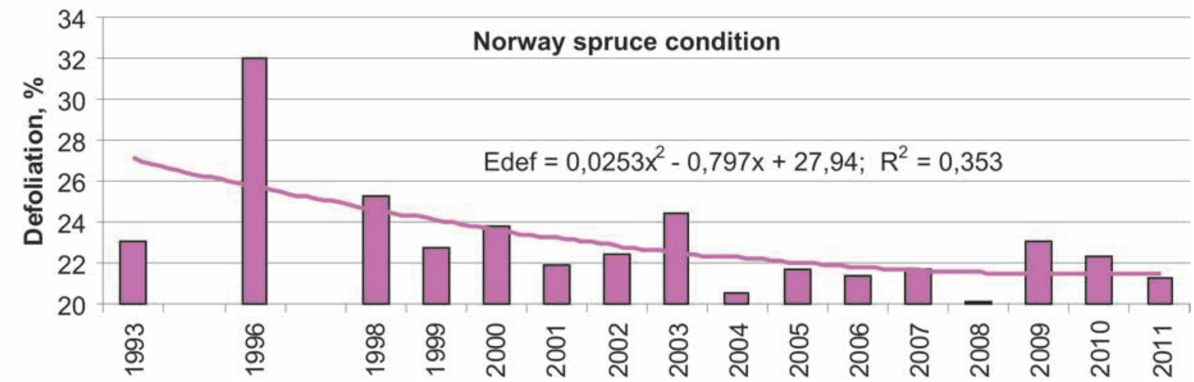
Crown condition of about 1000 trees (pine trees – 20%, spruce – 70% and birch – 10%) has been assessed employing the methodology of ICP Forest monitoring programme since 1994 (UN-ECE 1994) on 50 permanent observation plots (POPs) annually. Scots pine trees showed better condition than Norway spruce and Birch. In 1996 mean defoliation of trees reached the peak over the entire period of investigation 30.7±0.7%. Afterwards, crown condition started to improve that lasted until 2005. Since this year defoliation of the observed trees started increasing again.

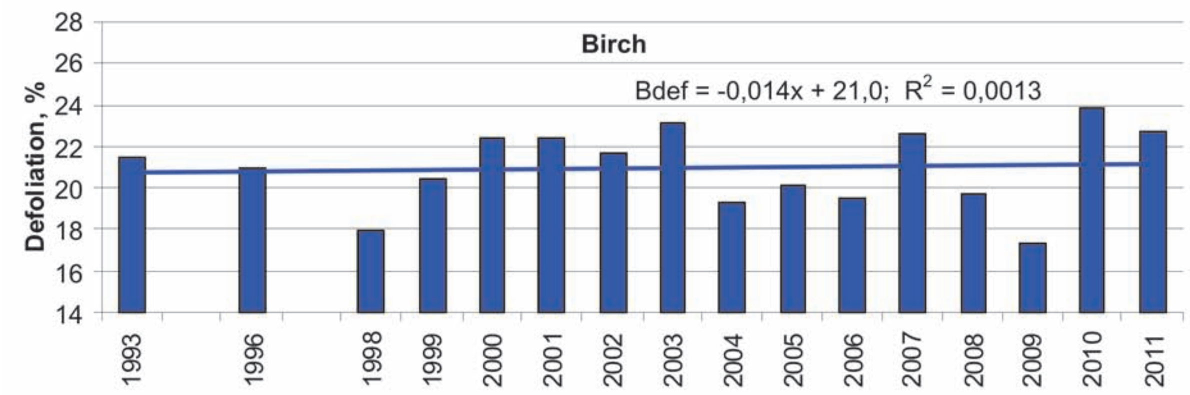
Changes in the mean defoliation of pine trees were mainly related to changes in air concentrations of aerosolic NO_3^-, NH_4^+ and SO_4^{2-}. Deposition of these compounds as well as ozone concentration did not increase the explanation rate of pine defoliation variability significantly. The indirect effect of acidifying compounds in soil and ground water on pine condition was considerably lower; however, this indirect effect increased the explanation rate of pine defoliation variability significantly by 14%, from 75% up to 89%.

By contrast, the indirect effect of N compounds through soil and ground water on birch defoliation was more significant (r^2=0.355) than the direct effect through the air on leaves (r^2=0.258). Therefore, we could conclude that needles, which are present on trees all year round, seem to be more efficient aerosol collectors than leaves. In most cases, the considered contaminants had a negative effect on crown condition, while nitrate - its deposition and concentration in soil and groundwater - had a positive effect. Contribution of peak O_3 concentrations to the integrated impact of acidifying species and meteorological parameters on stem radial increment was found to be more significant than its contribution to the integrated impact of acidifying species and meteorological parameters on defoliation of the considered tree species. The death of spruce trees due to *Ips typographus* L., did not allow to detect the effect of air pollutants, atmospheric deposition and surface ozone.

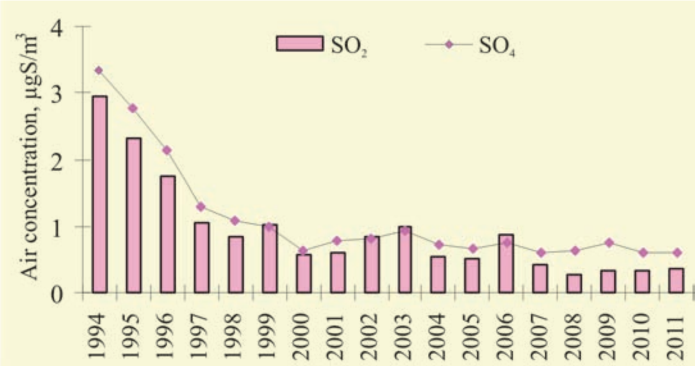

Aukštaitija IMS
Pine
Spruce
Birch
Defoliation, %
35
30
25
20
15
10
1993
1996
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011


Scots pine condition
Pdef = 0,077x2 - 1,91x + 28,15; R2 = 0,8667
Defoliation, %
1993
1996
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

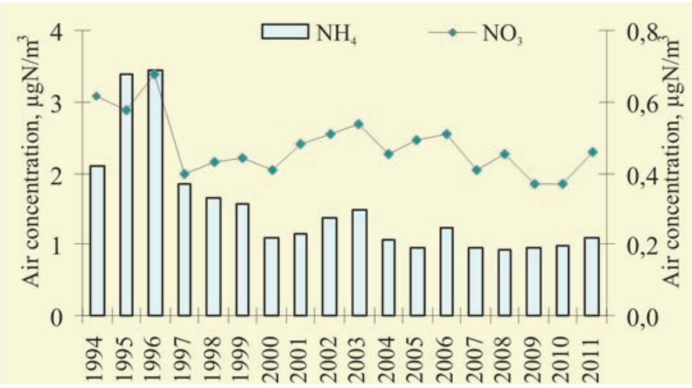

Norway spruce condition
Edef = 0,0253x2 - 0,797x + 27,94; R2 = 0,353
Defoliation, %
1993
1996
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011


Birch
Bdef = -0,014x + 21,0; R2 = 0,0013
Defoliation, %
1993
1996
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

Air concentrations:



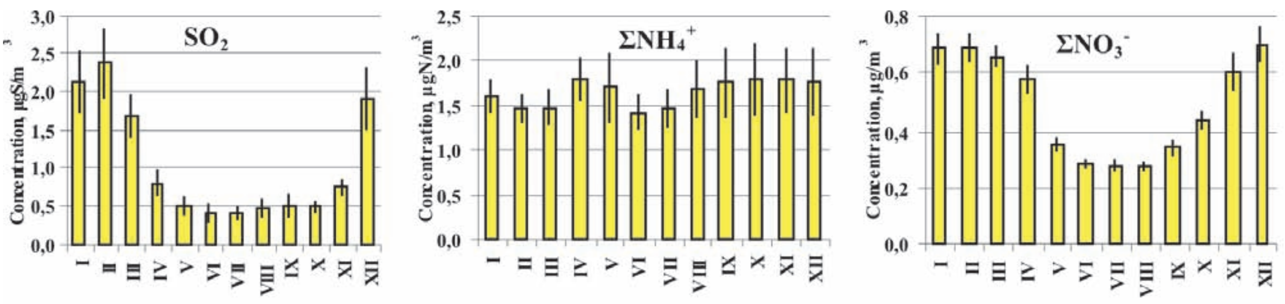
IMS data revealed a significant decrease in pollutant load until the year 2000. The air concentration of SO_2 at Aukstaitija IMS decreased by 82% (from 2.73 to 0.49 µgS/m^3). Thereafter, the concentration was stable at the level of 0.5 – 0.7 µgS/m^3. Air concentration of aerosolic SO_4^{2-} changed in a similar to SO_2 air concentration pattern. Since 2008 fluctuated around 0.3µgS/m^3.



The most significant decrease in ΣNH_4^+ air concentration lasted until 2001 and made 77% (from 4.44 to 1.02 µgN/m^3). During 2001-2007 period a stabilization of air ΣNH_4^+ concentration at the level of 1.1 – 1.3 µgN/m^3 was observed. Since 2008 insignificant increase has been recorded.

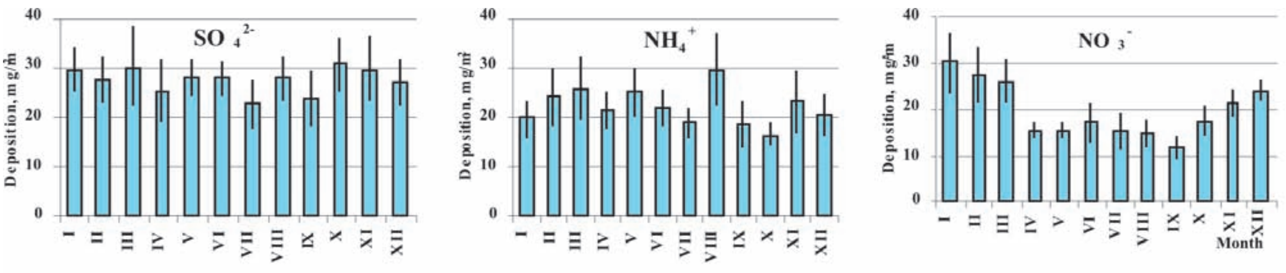
Annual means of ΣNO_3^- concentration in the air were stable at the level of 0.5-0.7 µgN/m^3. Over the last five years insignificant decrease in air concentration was also registered.

There was a very distinct seasonal variation in SO_2 concentrations. SO_2 concentrations reached their maximum values in winter and autumn, while minimum - in summer.

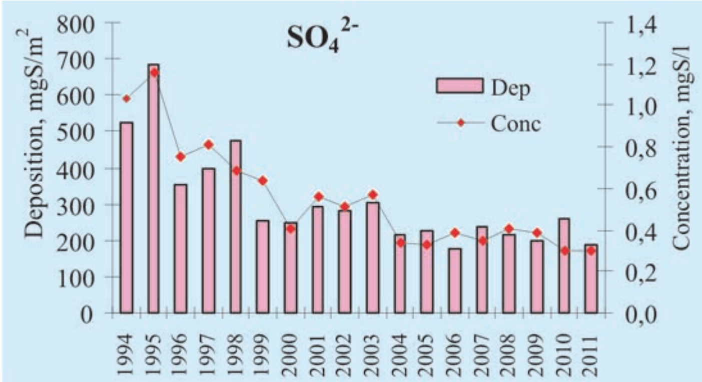


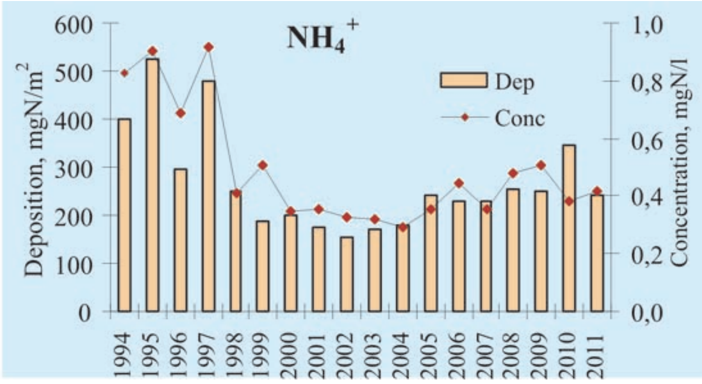
However, there was no clear trend in annual means of NO_2 at this station. Annual means of NO_2 were below 0.70 µg N m^{-3}. Over the last five years, total annual mean of NO_3 concentrations decreased by 10 % and now is below 0.58 µgN m^{-3}.

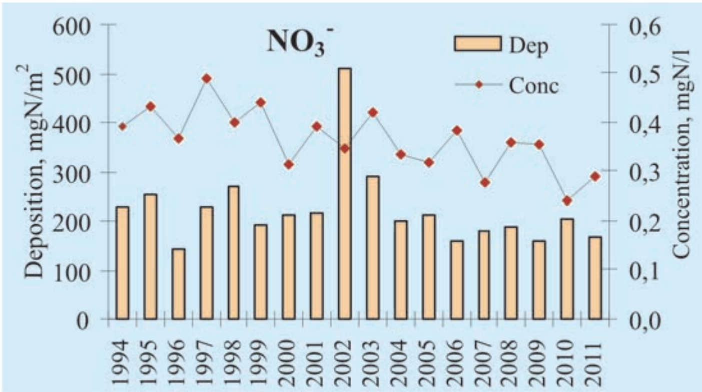
Seasonal variation in the atmospheric depositon of considered contaminants:



Acid deposition:







Changes in annual wet deposition had a very similar pattern to that of the air. The wet deposition of sulphur for the period 1994-2000 at the Aukstaitija IMS decreased by 58% (from 600 to 250 mgS/m^2). During 2001-2005 period at LT-01, sulphur deposition was further decreasing and reached 200 mgS/m^2. Since 2005 some stabilization in S deposition or insignificant reduction in S concentration in precipitation at this station has been monitored.

Decreases in annual wet deposition of NH$_4^+$ from 492 to 198 mgN/m^2 at LT-01 occurred until 2001. Afterwards, deposition level stabilised and since 2004 has shown a remarkable increase from almost 200 up to 320 mgN/m^2. This process can become a new threat for forest ecosystem and result in new acidifying processes in the soil.

Contrary to this, no significant change in wet deposition of NO$_3^-$ was observed. Its values ranged from 241 to 211 mgN/m^2, with the exception of 2002, when they reached the peak. Only the tendency towards decreasing of nitrate in precipitation was detected over the period of observation.

Despite this, total N deposition over 2001-2011 period started increasing again

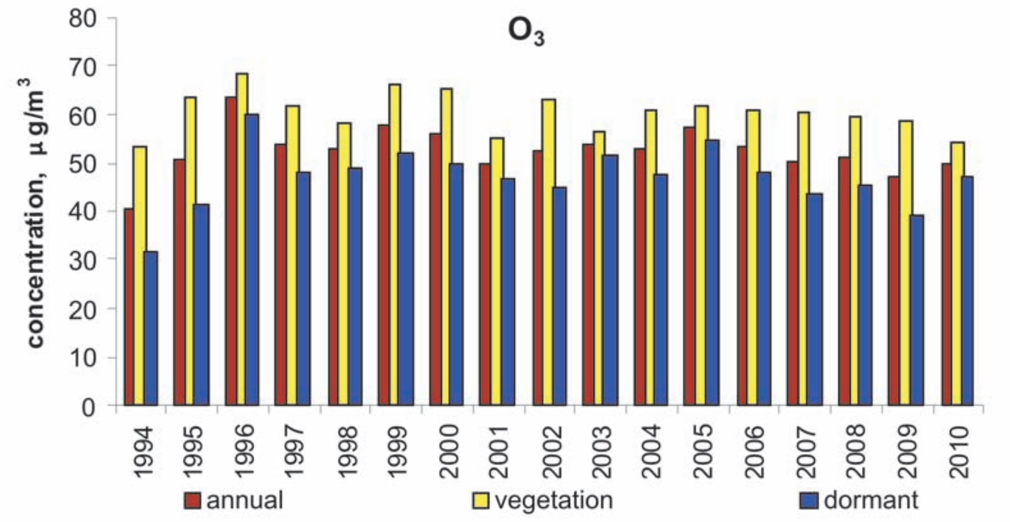
mainly due to increase in ammonium deposition. As a result of these changes in acidifying compounds until 2001 a more than tenfold decrease in H$^+$ concentration in precipitation and its deposition was observed, however, afterwards acidity of precipitation started increasing again mainly due to repeated increase in NH$_4^+$ deposition.

Therefore, even after a complete implementation of the Gothenburg Protocol and other current legislation, the effect of N deposition with commensurate adverse biological effects still remains one of the most relevant problems in Lithuania as well as in Europe, the USA and Canada.

Despite these international efforts N species remain at the same level or start demonstrating a trend towards increasing, especially ammonium, what should result in further acidification of soils and act to worsen the problem of forests acidification in future.

Ozone concentration:

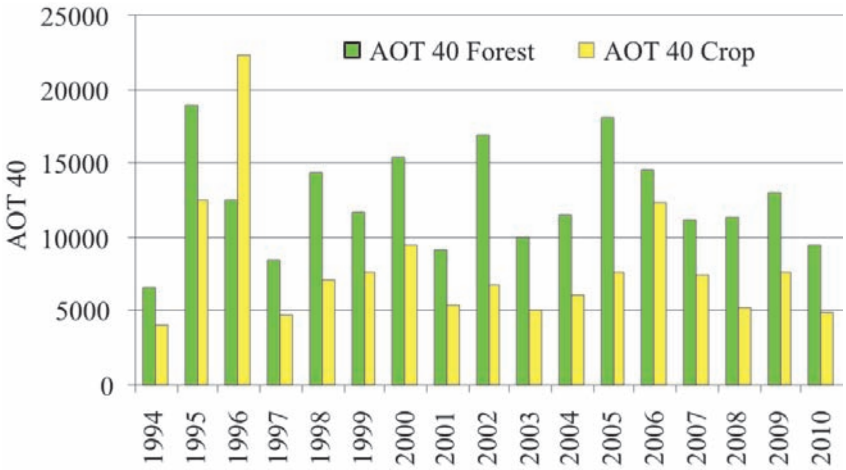
In contrast to reduction of sulphur emission, the continuing rise in the emissions of precursor substances resulted in a rise in ozone (O_3) concentrations, which as a phytotoxic pollutant and an agent of climate change, recently is considered to be the most important air pollutant for forests. O_3 concentrations are expected to substantially increase during summertime in future climate conditions. Recent changes in surface temperature should lead to increase in biogenic emissions of isoprene, a biogenic precursor of ozone. This process, which promotes an increase in surface ozone concentrations over southern and central Europe [52], should increase ozone concentrations in Lithuania as well. However data obtained from Aukštaitija IM station since 1994 do not confirm this state of knowledge.



O_3 concentration over vegetation and dormant periods since 1996 has decreased significantly, and made -0.50 µg/m^3 and -0.64 µg/m^3 per year, respectively. Such changes resulted in mean annual ozone concentration decrease by 0.58 µg/m^3 per year.

Concentration of O_3 among the concentrations of other monitored pollutants reached the closest to critical phytotoxic level. The AOT40 target values for the protection of vegetation were not reached in Aukštaitija IMS. The critical level 20000 µg/m^3 h for the protection of forest was observed only in 1996.

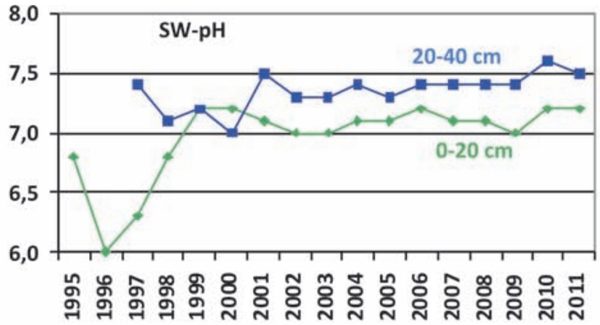
The data revealed that high ozone concentrations are usually attributed to polluted air transport from other regions, consequently ozone concentration and related parameters (AOT40, AOT60, etc.) will mainly depend on ozone precursor emissions in other regions in future, as Lithuania's contribution to photochemical ozone formation is limited.

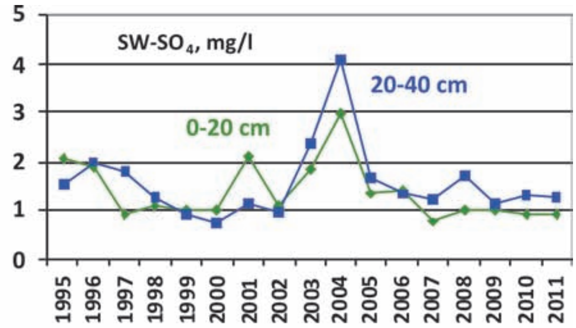


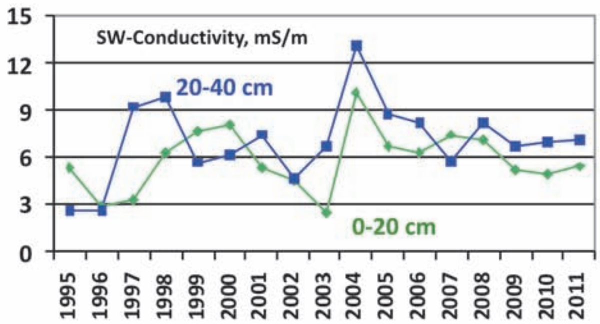
Soil, ground and surface water analysis:

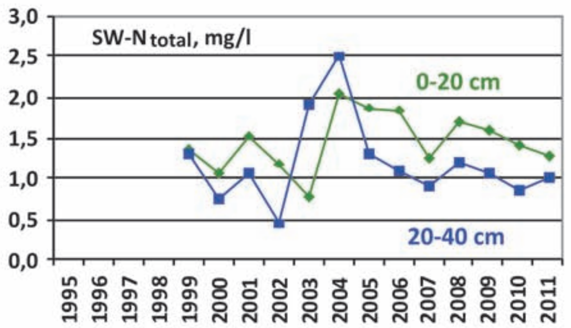
Soil water. Soil water lizimeters (plate type, surface area 625–1000 cm[2]) were installed on prevailing forest type of each catchment. Water samples were collected from two layers: at 10-20 cm (main root zone) and 30-50 cm (below main root zone) depth, installing 3 collectors in each layer; sampling period 3–4 times per vegetation period.

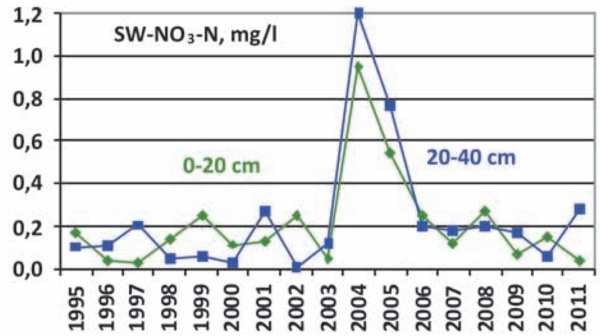
SO_4^{2-} concentration in soil water showed a decreased from 2 mgS/l at the beginning of investigation up to 1 mgS/l in recent years. The decrease in NH_4^+ concentration at LT-01 made about 0.03 mgN/l per year and over the last few years started increasing. NO_3^- concentration in soil water increased by 0.021 mgN/l per year. Since 1994 acidity of soil water at LT01 has decreased mainly due to the changes in Ca concentration, which increased there.

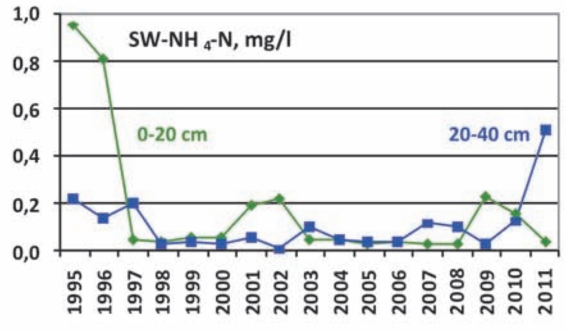


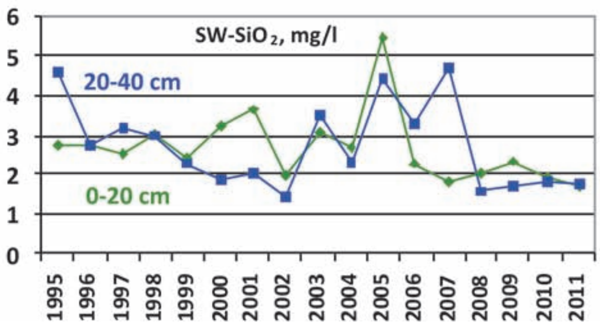


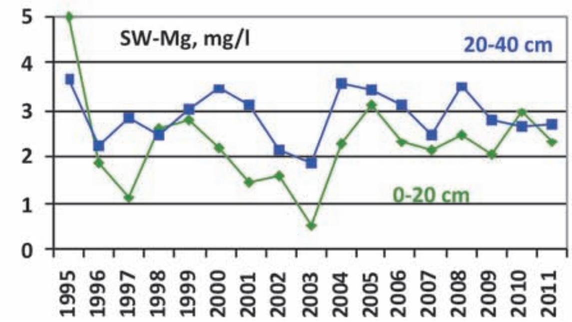


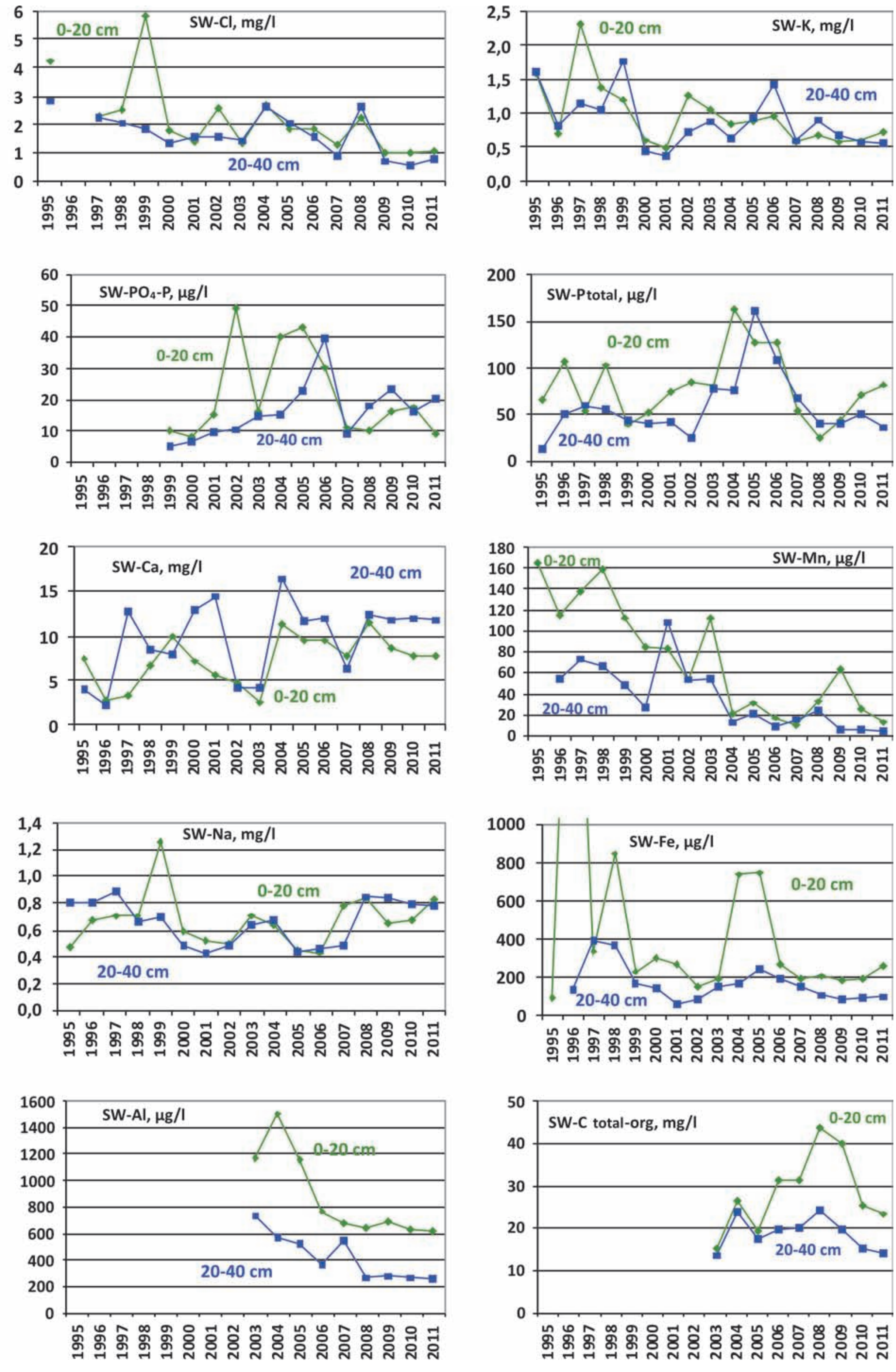


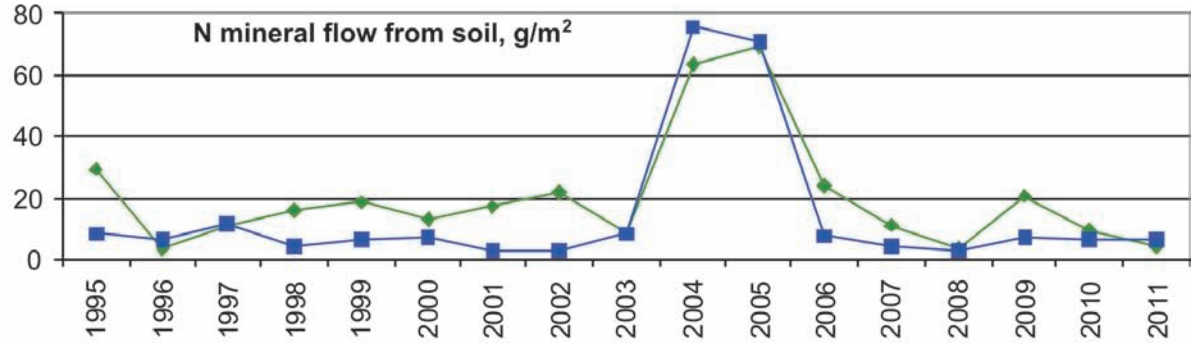


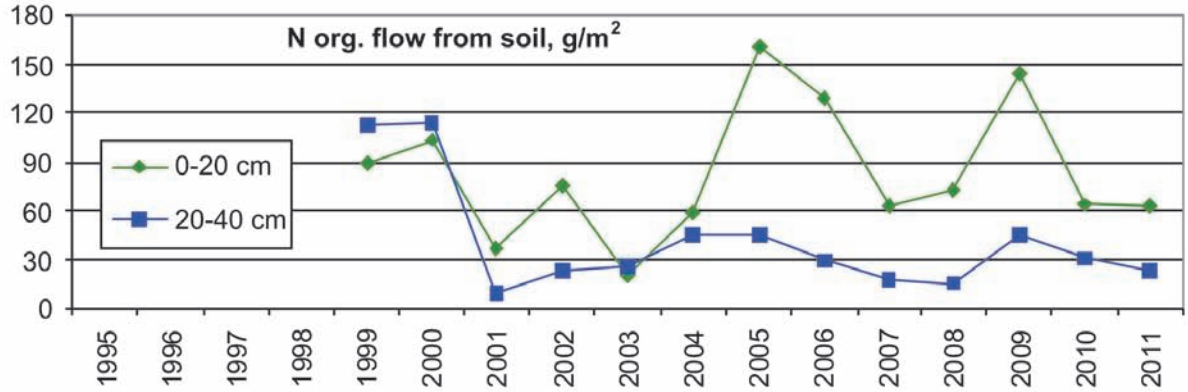


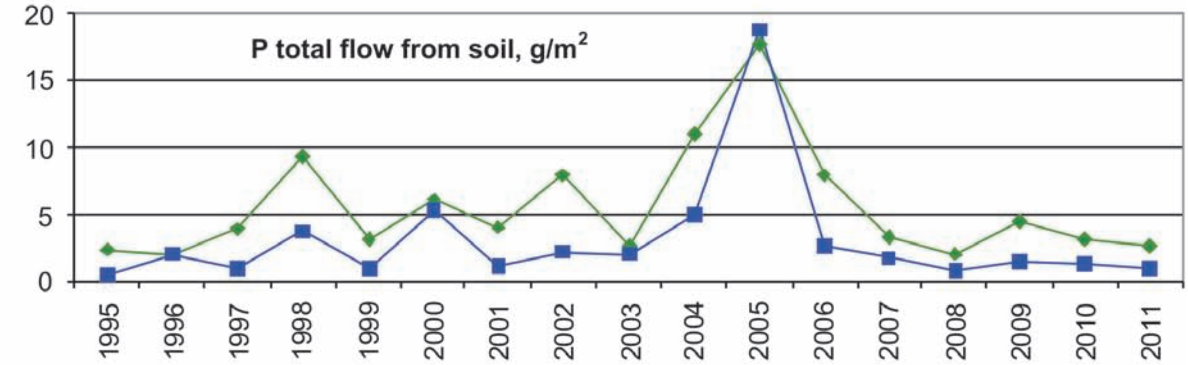


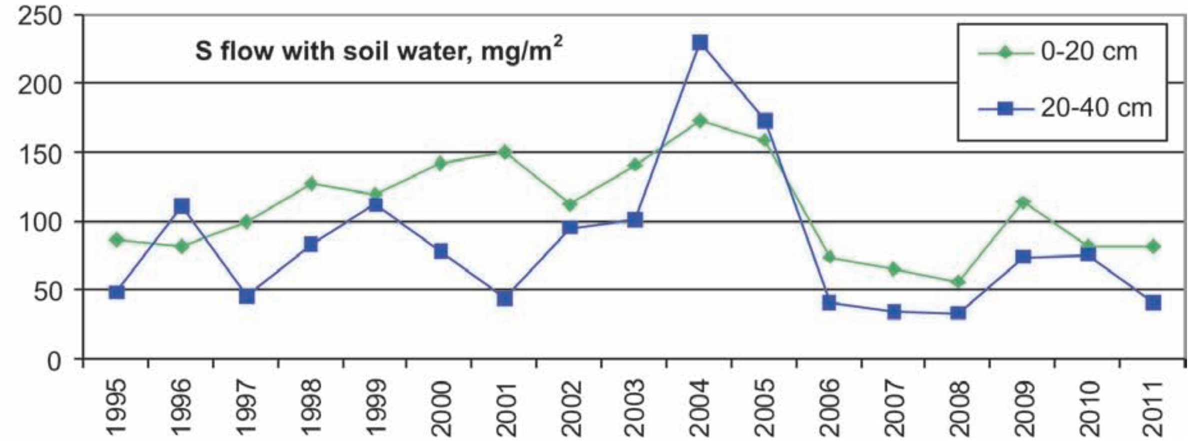



SW-Cl, mg/l
0-20 cm
20-40 cm
SW-K, mg/l
0-20 cm
20-40 cm
SW-PO4-P, µg/l
0-20 cm
20-40 cm
SW-Ptotal, µg/l
0-20 cm
20-40 cm
SW-Ca, mg/l
20-40 cm
0-20 cm
SW-Mn, µg/l
0-20 cm
20-40 cm
SW-Na, mg/l
0-20 cm
20-40 cm
SW-Fe, µg/l
0-20 cm
20-40 cm
SW-Al, µg/l
0-20 cm
20-40 cm
SW-C total-org, mg/l
0-20 cm
20-40 cm





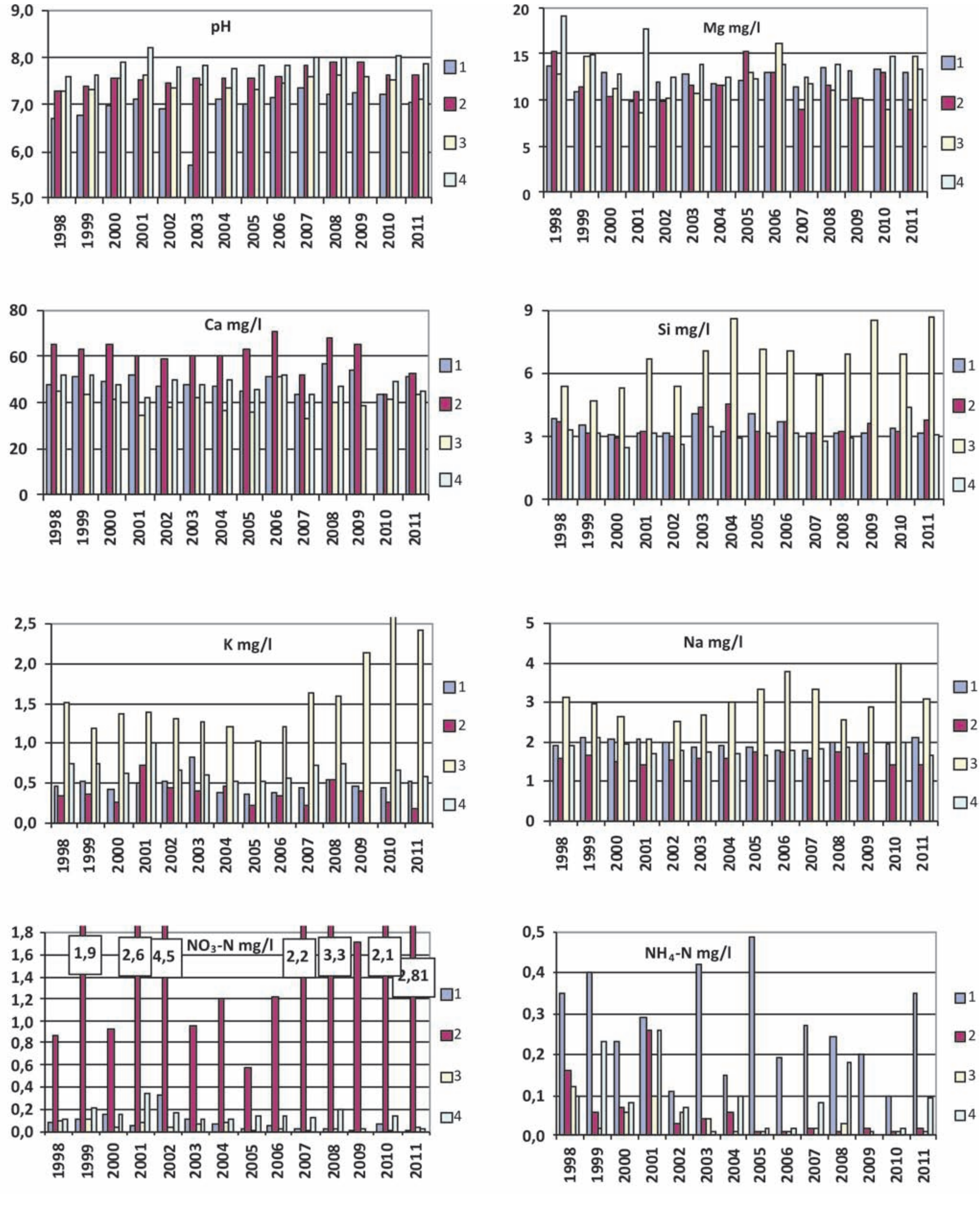


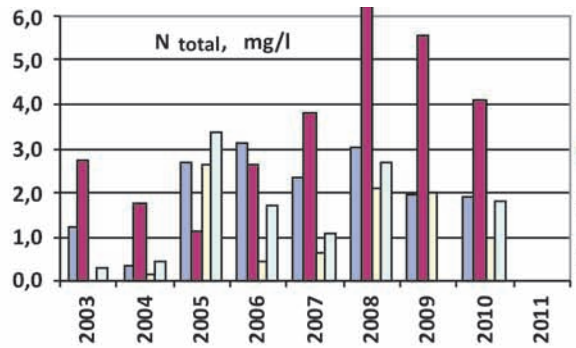


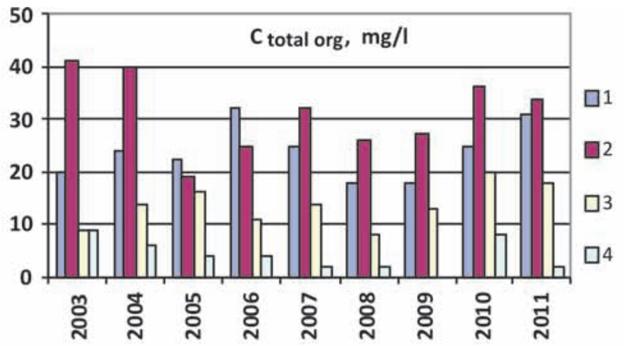
The lowest flow of NO_3^- 5-10 mg N m^{-2} per year in the soil water was recorded in the first years of observation (1995-1997). Afterwards, flow in soil water showed a tendency towards increasing and over 2004-2005 reached the highest level, 80–120 mg N m^{-2} per year, i.e. it was 8-12 fold higher than in 1995–1997. In 2006-2011 NO_3^- flow decreased a little and remained stable.

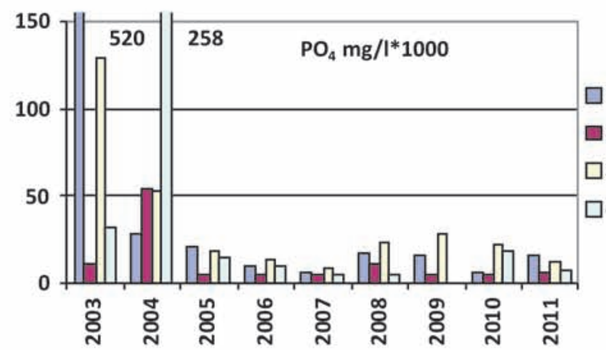
Ground water. Nitrate concentrations in the ground water of LT-01 had no statistically significant trends. NH_4^+ concentration showed a trend towards decreasing in all bores.

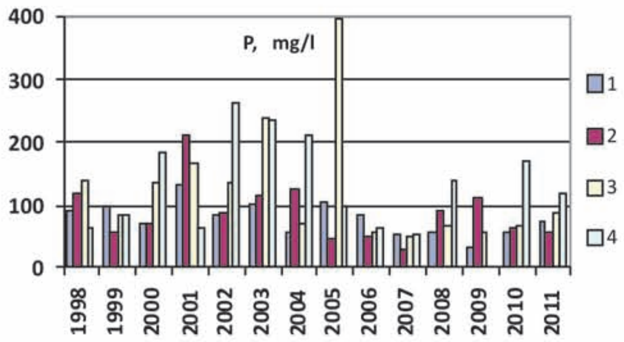
SO_4^{2-} concentration changes had no regular patterns at LT-01 station. The detected changes resulted in a gradual decrease of the ground water acidity at all considered depths.

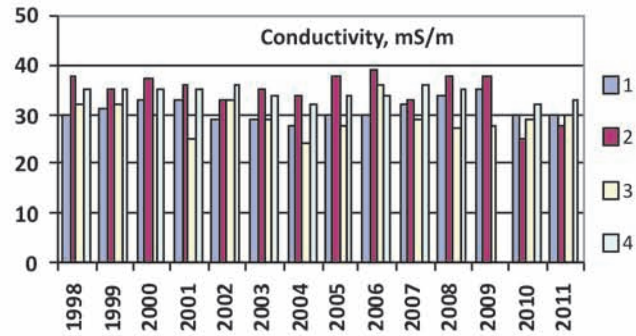


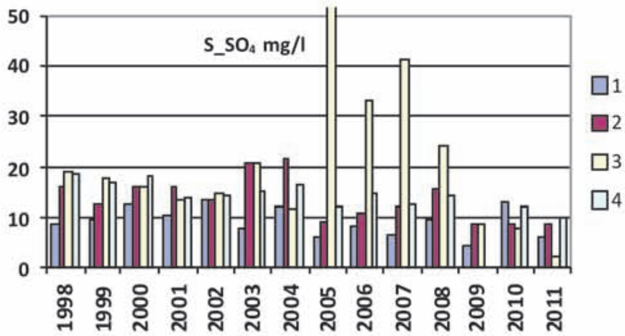

N total, mg/l
1
2
3
4

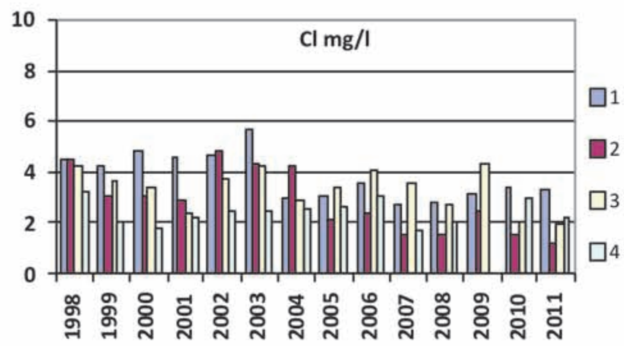

C total org, mg/l
1
2
3
4

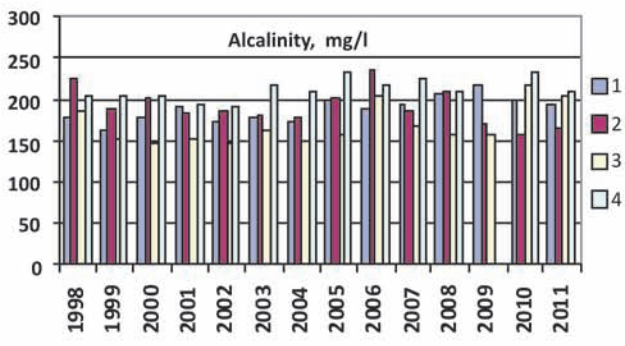

520
258
PO4 mg/l*1000
1
2
3
4

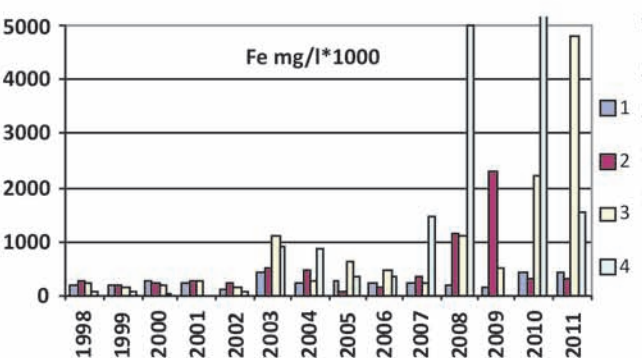

P, mg/l
1
2
3
4

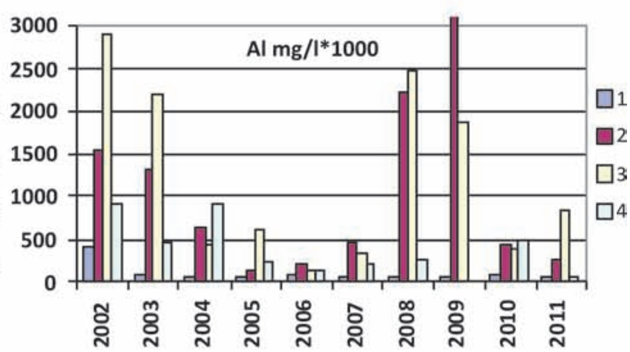

Conductivity, mS/m
1
2
3
4


S_SO4 mg/l
1
2
3
4

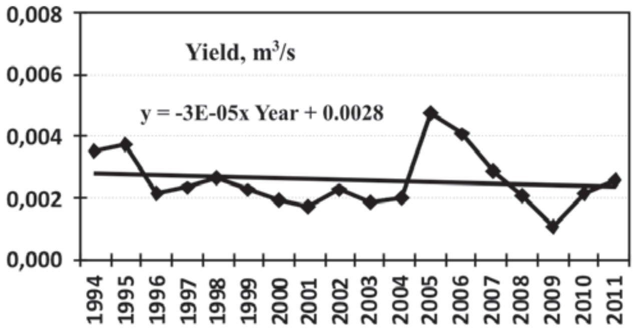

Cl mg/l
1
2
3
4

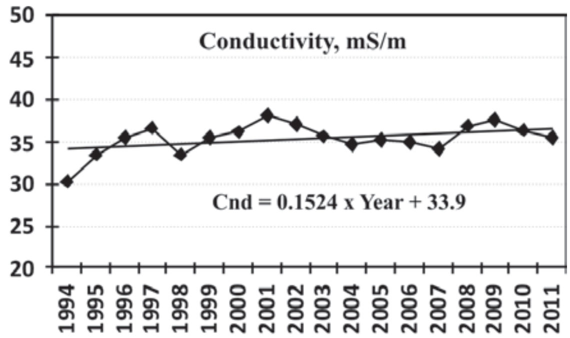

Alcalinity, mg/l
1
2
3
4

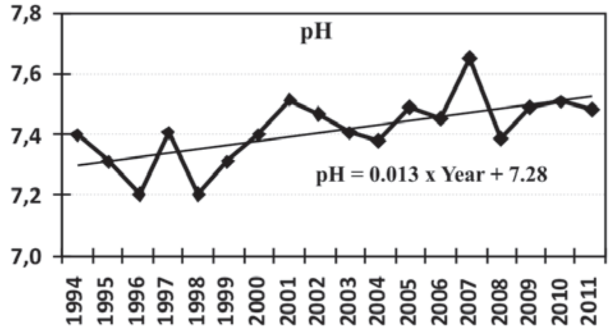

Fe mg/l*1000
1
2
3
4

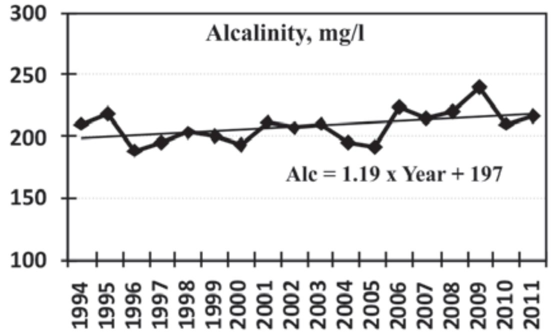

Al mg/l*1000
1
2
3
4

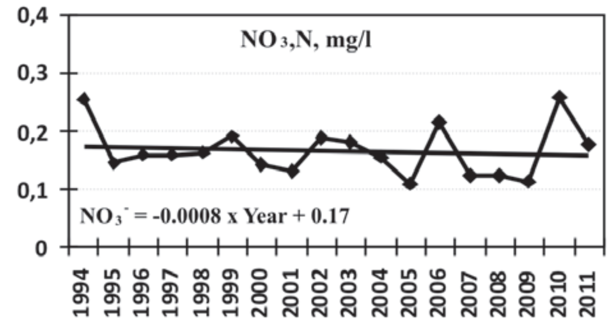
Runoff water. Stream water quality and runoff of the main chemical compounds from ecosystems reliably reflect a common tendency of the chemical processes occurring in forest ecosystems. Since 2001 concentrations of SO_4^{2-} in surface water showed a tendency towards decreasing. Concentration of NH_4^+ had a tendency to decrease until 2001. Since this year as a result of increase in NH_4^+ atmospheric deposition its concentration in runoff water started increasing. Despite this the acidity of surface water gradually decreased and over almost 20 year period pH increased from 7.3 up to 7.55. Only NO_3^- had no statistically significant trends.

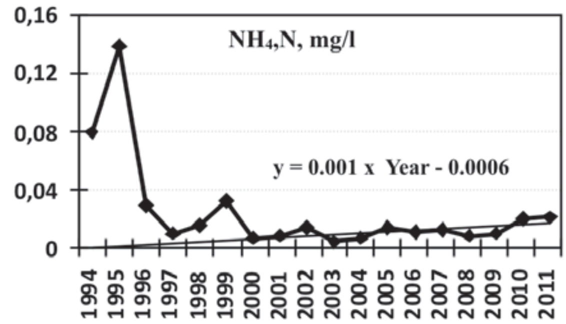


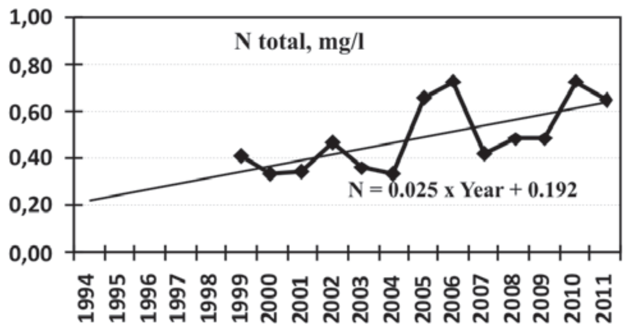


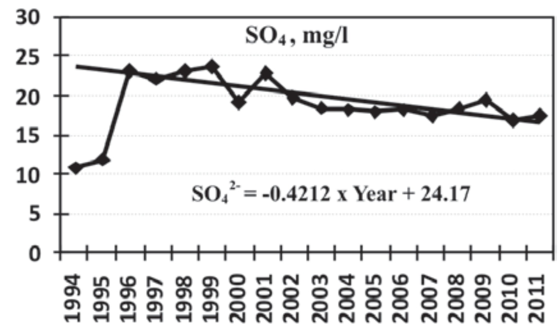


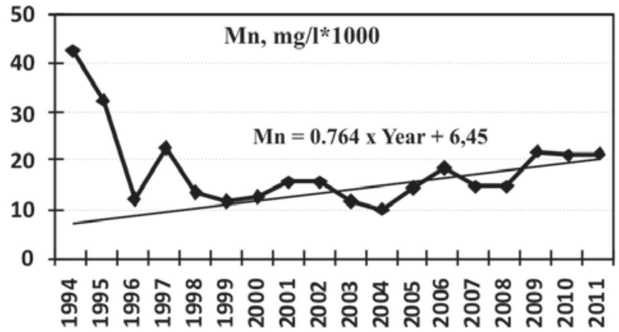


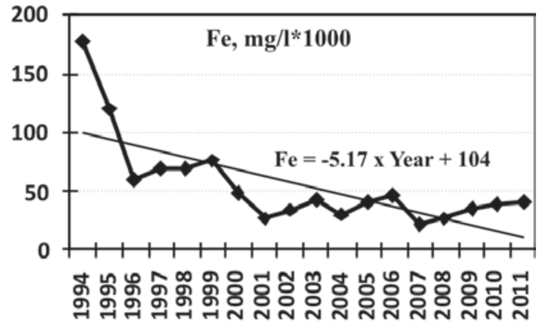


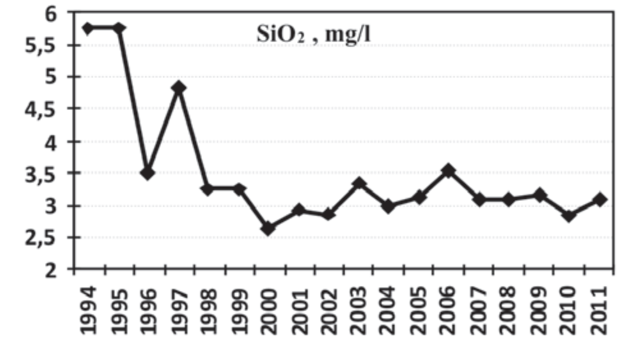


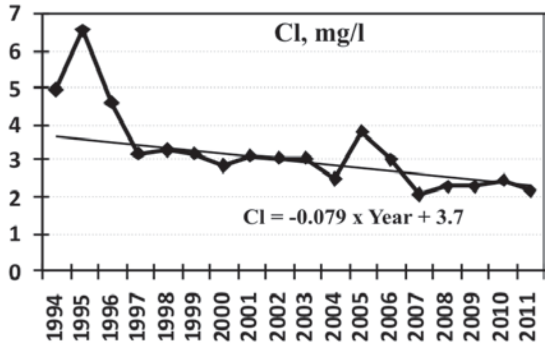


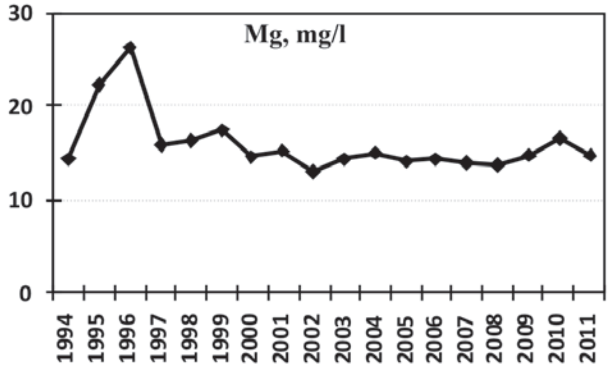


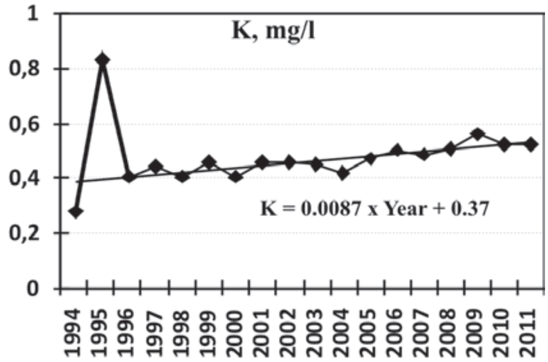

Mn, mg/l*1000
Mn = 0.764 x Year + 6,45

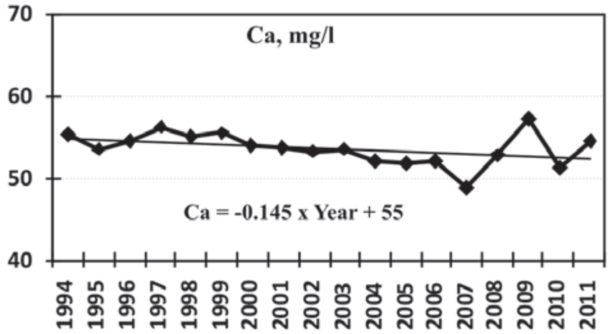

Fe, mg/l*1000
Fe = -5.17 x Year + 104

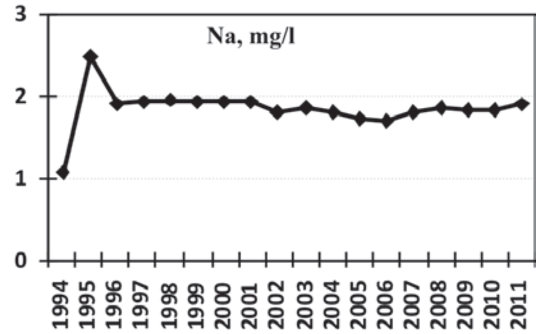

SiO2 , mg/l

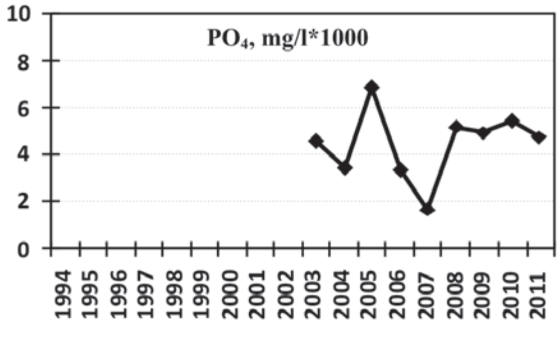

Cl, mg/l
Cl = -0.079 x Year + 3.7

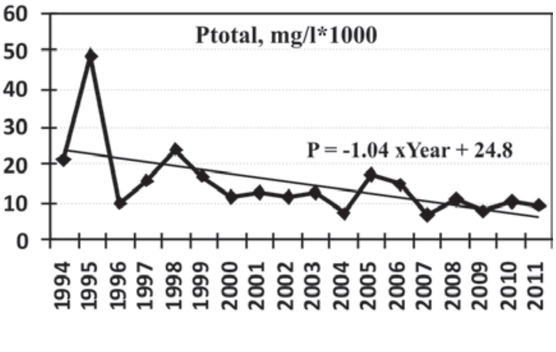

Mg, mg/l


K, mg/l
K = 0.0087 x Year + 0.37


Ca, mg/l
Ca = -0.145 x Year + 55

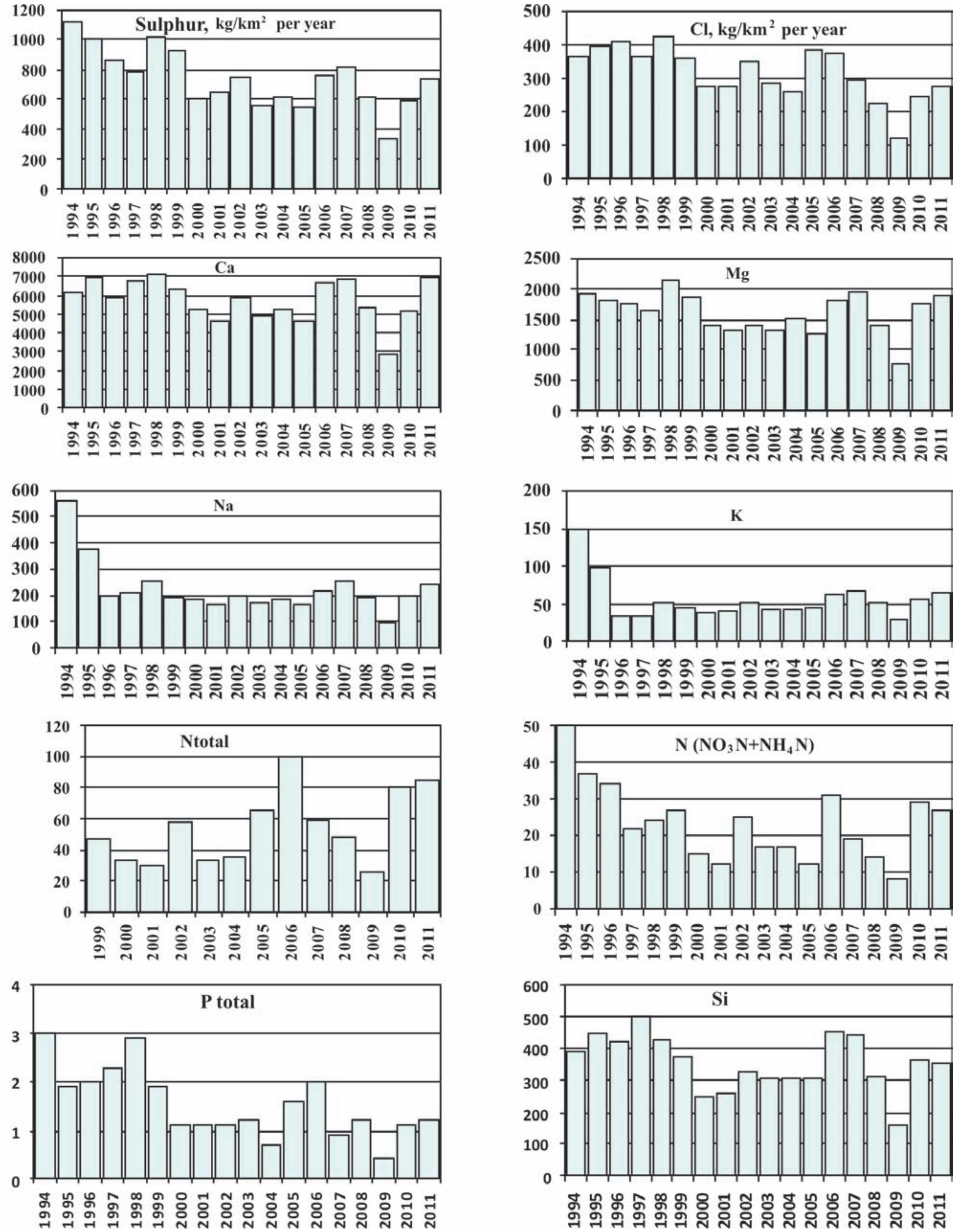

Na, mg/l


PO4, mg/l*1000


Ptotal, mg/l*1000
P = -1.04 xYear + 24.8

Run of with surface water.

Output data on S, Cl, Mg, P and Si compunds with surface water revealed the decrease tendency. Contrary to this output of total nitragen demonstrated trend towardws increasing.



Output of the considered compounds with surface water (kg/km^2 per year)

Relationships between deposition of S and N compounds and their concentrations in soil, ground and surface water

Nitrogen (N) deposition, meaning inorganic ammonium (NH_4^+) and nitrate (NO_3^-) disrupting the ratio between dissolved organic and inorganic N available to plants, is among key factors resulting in spatial and temporal changes in forest ecosystems condition and productivity.

In most cases, changes in NH_4^+ concentration in soil and ground water could be explained by variation in concentrations in the air, precipitation and deposition. These concentrations increased with an increase in NH_4^+ deposition level and concentrations in the air and precipitation. NO_3^- concentrations in soil and ground water were less related to concentrations in air, precipitation or deposition. However, these changes were often related to NH_4^+ concentration in the air; precipitation and deposition indicating the occurrence of nitrification in the soil.

Table Relationships between N compounds in the air, precipitation, and deposition with their concentrations in ground (GW), soil (SW) and runoff (RW) water

	Concentration in the air ($\mu g/m^3$)			Wet deposition (mg/m^2)				In precipitation (mg/l)			
IMS	SO_2	NO_3^-	NH_4^+	SO_4^{2-}	NH_4^+	NO_3^-	H^+	SO_4^{2-}	NH_4^+	NO_3^-	H^+
SO4_GW	-0.133	-0.155	-0.162	**-0.266**	-0.091	**-0.337**	**-0.273**	-0.206	-0.025	-0.143	-0.260
NH4_GW	0.545	0.494	0.681	**0.629**	0.587	**0.364**	**0.598**	**0.651**	**0.559**	**0.447**	**0.644**
NO3_GW	-0.133	-0.007	-0.131	-0.129	-0.228	0.080	-0.104	-0.141	-0.219	0.012	-0.108
SO4_SW	-0.142	-0.115	0.111	-0.151	-0.018	-0.035	0.029	-0.137	0.002	-0.195	0.030
NH4_SW	**0.544**	**0.724**	**0.907**	**0.670**	**0.584**	**0.445**	**0.733**	**0.721**	**0.569**	**0.550**	**0.810**
NO3_SW	-0.184	0,035	-0,094	-0,181	-0,138	-0,099	0,269	-0,261	-0,228	**-0,449**	0,197
SO4_RW	**-0,541**	**-0.696**	**-0.498**	**-0.610**	**-0.508**	-0.261	**-0.924**	**-0.536**	-0.375	-0.085	**-0.905**
NH4_RW	**0.717**	**0.729**	**0.922**	**0.769**	**0.723**	**0.412**	**0.795**	**0.826**	**0.705**	**0.606**	**0.863**
NO3_RW	**0.612**	0,354	0.145	**0.561**	0.338	**0.482**	**0.534**	**0.491**	0.258	**0.404**	**0.487**

Note: GW – ground water; SW – soil water; RW – runoff water; significant correlation in bold ($p<0.05$)

Changes in concentrations of N compounds in stream water were significantly related to changes in air, precipitation as well as deposition. In addition, contrary to these processes, increased concentrations of SO_4^{2-} in stream water highly correlated with decreased concentrations of SO_2 in the air and SO_4^{2-} deposition. It is highly probable that after remarkable decrease in SO_2 concentration in the air and sulphates deposition, forest ecosystems became cleaner due to leaching processes which took place in nature. As a proof of the possible processes in forest ecosystem, an adverse significant effect of SO_4^{2-} concentrations in stream water and defoliation of the considered tree species was detected.

The increase in leaching of N compounds can most likely be related not only to the contamination of precipitation, but also to mineralization of the organic matter and nitrification processes which lately have become more intensive due to climate warming. More than 0.19 m/l of NO_3^- was found in the stream at LT01 in 1995 and 2002-2003. With intensification of mineralization and nitrification processes, a part of N goes directly to the atmosphere. Therefore, the contamination of precipitation with N compounds can be of a local character. More detailed studies should allow determining whether transformation of organic mater in soil or contamination of precipitation result in the increase of NO_3^- concentration in the stream water.

Long term monitoring plan of air chemistry and natural forest ecosystem at IMS

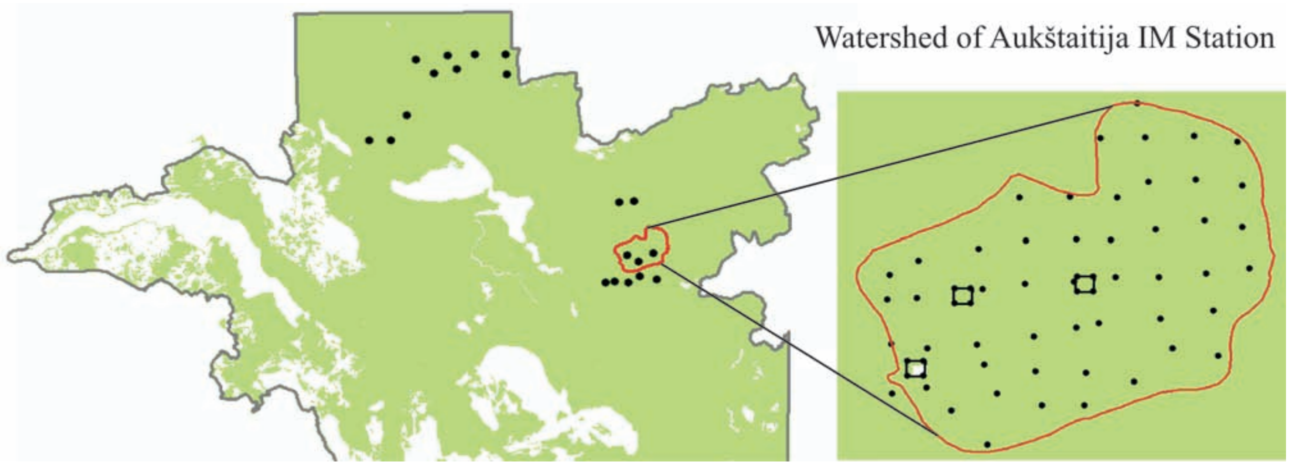
Eil. Nr.	Group of parameters	Parameters	Measurement units	Sampling frequency	LTER sites		
					Aukstaitija LT-01 ICP IMS	Zemaitija LT-03 ICP IMS	Curonian Spit NP LT-15 ICP EMEP & Preila meteostat
1.	Meteorological data	Precipitation amount	mm	*Continuosly*	+	+	+
		Air and soil temperature	ºC		+		+ -
		Humidity relative	%		+		+
		Wind direction	degrees		+		+
		Wind speed	m/s		+		+
		Total radiation	W/m^2		+	+	
		FAR	W/m^2		+		
		UV-B radiation	W/m^2		+		
2.	Air chemistry	SO_2-S, SO_4-S, NO_2, (NO_3^-+HNO_3), (NH_3+NH_4^+)	$\mu g/m^3$	IMS every week, EMEP-daily	+	+	+
		O_3	$\mu g/m^3$	*Continuosly*	+	+	+
		Pb, As, Cd, Ni, Hg, PAA according to possibility	ng/m^3	every 72 h	+		+
3.	Precipitation chemistry	Amount of precipit	mm	Every month,	+	+	+
		pH	-		+	+	+
		NO_3-N, NH_4-N, SO_4-S, Cl, K, Na, Ca, Mg	mg/l		+	+	+
		Conductivity	mS/m		+	+	
		Alkalinity	mmol/l		+	+	
4.	Heavy metals in precipitation	Cd, Cu, Pb, Ni, Mn, Fe, Cr, Zn	µg/l	Heavy metals– more than 12 per year	+	+	+

Eil. Nr.	Group of parameters	Parameters	Measurement units	Sampling frequency	LTER sites Aukstaitija LT-01 ICP IMS	Zemaitija LT-03 ICP IMS	Curonian Spit NP LT-15 ICP EMEP & Preila meteostat
5.	Soil water chemistry	pH	-	From IV to XI every	+	+	
		Conductivity	mS/m		+	+	
		Alkalinity	mmol/l	month	+	+	
		NO_3-N, NH_4-N, N_{total}, SO_4-S, SiO_2, Cl, K, Na, Ca, Mg, soluble org C	mg/l		+	+	
		Al_{tot}, Mn, Fe, PO_4-P, P_{tot}	µg/l		+	+	
		Soil humidity	m^3/m^3		+	+	
		Soilwater flow	$l/s \times km^2$		+	+	
		Cu, Zn, Pb, Cd, Cr, Ni	µg/l	3 times per year	+	+	
6.	Ground water chemistry	Deep	cm	Every 2	+	+	
		pH		months	+	+	
		Conductivity	mS/m		+	+	
		Alkalinity	mmol/l		+	+	
		NO_3-N, NH_4-N, N_{total}, SO_4-S, SiO_2, Cl, K, Na, Ca, Mg, C soluble org	mg/l		+	+	
		Al_{tot}, Mn, Fe, PO_4-P, P_{tot}	µg/l		+	+	
		Cu, Zn, Pb, Cd, Cr, Ni	µg/l	3 times per year	+	+	
7.	Runoff water chemistry	Runoff	$l/s \times km^2$	Monthly	+	+	
		Water temper.	ºC		+	+	
		pH			+	+	
		Cation and anion balance	meq/l		+	+	
		Electrical conductivity	mS/m		+	+	
		Alkalinity	mmol/l		+	+	
		NO_3-N, NH_4-N, N_{total}, SO_4-S, SiO_2, Cl, K, Na, Ca, Mg, dissolved org C, O_2	mg/l		+	+	
		Al_{tot}, Mn, Fe, PO_4-P, P_{total}	µg/l		+	+	
		Cu, Zn, Pb, Cd, Cr, Ni	µg/l	4 times per year	+	+	

Eil. Nr.	Group of parameters	Parameters	Measurement units	Sampling frequency	LTER sites Aukstaitija LT-01 ICP IMS	Zemaitija LT-03 ICP IMS	Curonian Spit NP LT-15 ICP EMEP & Preila meteostat
8.	Soil chemistry	pH($CaCl_2$)	-	1 time	+	+	
		total org C; S_{total}, N_{total}, P_{total}	mg/kg	per 5 years	+	+	
		exchangeable titrable K, Na, Ca, Mg, Al; exchangeable titrable (H+AL)	meq/kg		+	+	
		Cd, Cu, Pb, Ni, Cr, Zn	mg/kg		+	+	
		Volume weight	kg/m^3		+	+	
		CEC	meq/kg		+	+	
		ANC	%		+	+	
		particle size analysis exchangeable titrable Mn, Fe	% meq/kg		+	+	
9.	Hidrobiology of stream	Biodiversity and abundance	$ind./m^2$	2 times per year	+	+	
		Biomass	g/m^2		+	+	
		Shenon-Weener biodiversity index	index		+	+	
10.	Leaf/needle chemistry	1000 needles /100 leaf mass	g	1 time per year	+	+	
		N_{total}, P_{total}, K, Ca, Mg	mg/g		+	+	
		Na, Zn, Mn, Fe, Cu, Cl, Cd, Pb, Al_{total}, Cr, Ni	µg/g		+	+	
11.	Literfall chemistry	Amount	g/m^2	Monthly from IV to XI	+	+	
		N_{total}, P_{total}, K, Ca, Mg	mg/g	5 times per year	+	+	
		Na, Zn, Mn, Fe, Cu, Cl, Cd, Pb, Al_{total}, Cr, Ni	µg/g		+	+	
12.	Heavy metals in mosses	Cd, Cu, Cr, Fe, Ni, Pb, Zn, Mn	mg/kg	1 time per 5 year s	+	+	

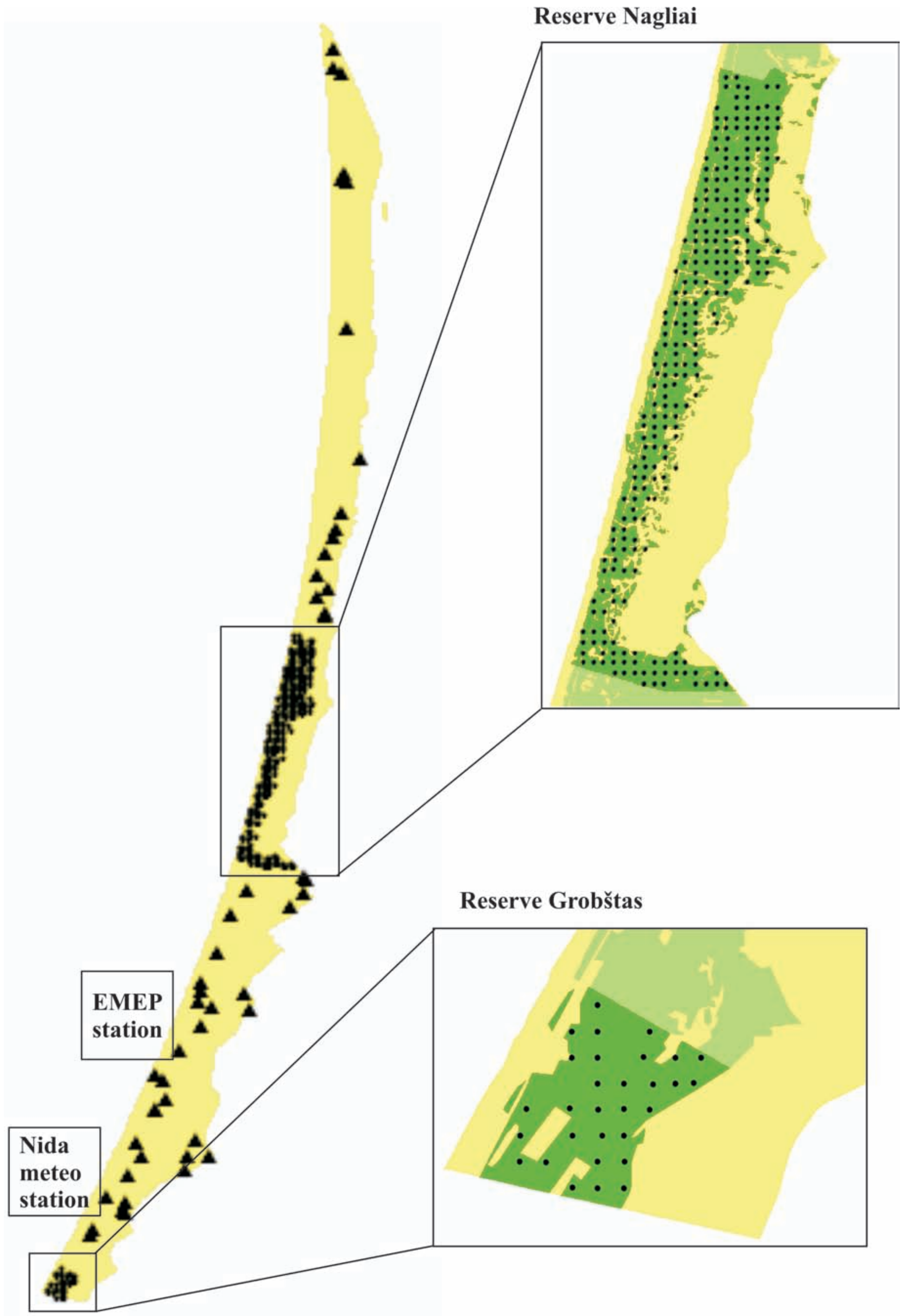
Eil. Nr.	Group of parameters	Parameters	Measurement units	Sampling frequency	LTER sites: Aukstaitija LT-01 ICP IMS	LTER sites: Zemaitija LT-03 ICP IMS	LTER sites: Curonian Spit NP LT-15 ICP EMEP & Preila meteostat
13.	Stand parameters	Stem diameter	cm	1 time per 5 years	+	+	+
		Tree height, crown height and width	m		+	+	+
		Crown covering	%		+	+	+
		Defoliation, depigmentation, damages	%		+	+	+
		Damages by ozone	%		+	+	
		FAR under canopy	µmol/m^{2}s		+	+	
		LAI, Tree mortality, regeneration and productivity	unit/ha		+	+	+
		Stand biomass	t		+	+	
14.	Herb vegetation	Diversity	-	1 time per year	+	+	
		Fertility	class		+	+	
		Frequency and covering	(%)		+	+	
		Index.	index		+	+	
15.	Epyphitic lichens	Diversity	-	1 time per year	+	+	+
		Frequency and covering	%		+	+	+
		Length	cm		+	+	
		Vitality	class		+	+	+
		Community changes	%		+	+	
		Tree species	-		+	+	+
		Tree diameter	cm		+	+	+
16.	Green algae	Needle age	m	1 time per year	+	+	
		Needle mass	%		+	+	
		Covering intensity	%, kode		+	+	
		Tree diameter	cm		+	+	
17.	Pedobiont	Pedobiont density (ind./m^2)	ind./m^2	5 times per year	+	+	
		Amount of species, dominavimo koeficientas	unit		+	+	
18.	Microbiological soil activity	Cellulose destruction rate	%	5 time per year	+	+	
		Mineraliztion	kg/kg		+	+	
		Transpiration	mg/g x h		+	+	
		Phosphatic soil activity	µmol/g x h		+	+	

Location of permanent observation plots at long term ecological research sites



Research objects in Aukštaitija National park

Research objects in Žemaitija National park



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Acknowledgements:

First and foremost we would like to thank Andrzej Bytnerowicz and Elena Paoletti for understanding and invaluable assistance in organizing the conference and support for Lithuanian scientists.

We would like to express our gratitude and appreciation to the chair persons of scientific sessions for close collaboration preparing the program and editing the abstracts.

We would also like to thank:

Rector's office, Faculty of Forestry and Ecology as well as the administration, and technical personnel of the university for providing stimulating environment and good facilities;

Kęstutis Armolaitis and Romaldas Juknys for assistance in organizing the in-conference scientific trip to JV 'Achema' surrounding forest;

Director of the Curonian Spit national park Tomas Tukačiauskas and vice director Lina Dikšaitė as well as former and recent foresters of Nida forest enterprise Gediminas and Kęstutis Dikšai for organizing the pre-conference scientific sessions;

Algirdas Gavanauskas, Almantas Kliučius, Marius Kavaliauskas, Mantas Pilkauskas from the host team for the help in organizing the conference as well as the pre- and post- conference tours;

Gintaras Pivoras, the head of Aukštaitija IMS, for scientific session at this IM station;

Our special thanks go to Marcus Shaub for his idea to organize North American Air pollution workshop in Europe and good will to change Switzerland to Lithuania;

Head of the Department of Ecology dr. Vitas Marozas for his input and assisting us in many different ways

Our deepest gratitude is also due to the sponsors of the conference:

USDA Forest Service International programs for supporting the students and young scientists;

ENVeurope project for supporting publication of the conference materials and its leader Alessandra Pugnetti for cooperation in organizing the joint meeting;

Swedish University of Agricultural Sciences and prof. Lars Lundin for the support of ICP IM Task force meeting;

JV"Achema" for sponsoring the in-conference scientific trip;

Forestry Department of Ministry of Environment,

Lithuanian Forest Inventory and Management Institute and its director Alfredas Galaune for his help and technical assistance;

The Research Council of Lithuania for covering the accommodation fee of the students and young scientists on University Campus;

Union of Lithuanian Foresters and its president dr. Edmundas Bartkevičius;

Special tanks also go to Arvydas Barysas, camera-man, for video presentations and organization of pre- and post- conference tours as well as old Lithuanian songs.

Without the generous help and good will of these individuals and organizations this meeting would not have been possible.

Our best and sincere wishes to all of you!

Ingrida and Algirdas Augustaitis

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