
**2024 World Wood Day Online Symposium and**

**The Sixth IUFRO Forest Products Culture Colloquium**

# ABSTRACT BOOKLET

March 21st-22nd (UTC)

# 2024 World Wood Day Online Symposium and

# The Sixth IUFRO Forest Products Culture Colloquium

**Date:** 21-22 March, 2024

## Theme

Diversity of Wood in Culture

## Rationale

Diversity of Wood in Culture Wood is undeniably the most versatile raw material found in nature and made available to humanity for its various structural and non-structural products or applications in human society. Our world's diverse terrestrial environment being clearly distinct between geographical regions, ranging from the warm tropics to the cool temperate climes where tree growth occurs, is therefore home to a multitude of forest tree species distinctly adapted to differing climates such that no same wood species grows across all regions. With forest ecosystems differing between regions, unique utilisable forest tree species are only grown in that region of the world. For example, the famed tropical hardwood Belian (=Borneo Ironwood) is unique only to the Bornean humid tropics of Sarawak, Sabah and Kalimantan, and is a well-renown commercial timber for its exceptional strength (structural value), natural durability (remarkable resistance against wood destroying termites and rot fungi which assure an unusually long service life even as ground-contact

wooden structures) has almost no equivalent in wood quality elsewhere. Since the dawn of human civilization, humanity from different regions have embraced wood products harvested from tree species found only in their regions and have come to treasure and appreciate the native woods they utilise in society which becomes part of their cultural heritage and historical value. Evidence of ancient/historical accounts of wood utilization are aplenty; examples such as the famed Biblical description of Noah's use of an unknown acacia wood species for constructing a massive wooden ark brushed over with some kind of water-resistant oil-based compound, ancient Phoenician civilization that originate in the Levant region on the eastern Mediterranean (around present-day Lebanon) developed expansive maritime trade over a millennium due to their wide use of cedar wood in shipbuilding, while much later, historical use of oak woods found in much of Europe for warships of the English or Spanish armada are also well-known, and ancient Mayans of central American region has used wooden beams in temples. Indeed, through constant use of particular wood species for essential products beneficial to various societies around the world, such wood products, especially larger constructions, would thus be valued as part of human culture (contemporary or historical) in various regions for their distinct architectural beauty and acceptance.

How and why a particular wood species is processed and used by various societies over millennia is closely connected to the cultural heritage of each society while realising a challenge to define wood quality in relation to target wood products. Wood is what it is because it is formed from trees, and to understand wood is to understand how trees produce wood. Cultural appreciation of wood should thus incorporate much cultural appreciation of trees

and forest types with the hope that sustainable forest management and forest rehabilitation activities persist to ensure sustainable supply of much-needed wood to society. Wood suitable for pulp and paper-making or fuelwood may not be useful structural material, for example. Indeed, understanding wood properties of various woods of the world is essential to efficient utilisation of wood products providing informed choices for non-structural and structural uses. Unlike before, contemporary societies have developed wood and fibre science technologies to explore deeply into wood (as well as wood composite) quality of various wood species which reinforces man's understanding and classification of woods for specific applications and such knowledge also reinforces man's cultural/sociological appreciation of wood. Since ancient use of natural durable woods in construction, wood protection technologies are being developed to enhance biological resistance of previously low natural durability wood species (and related composite materials) for longer-term uses thus extending the range of other reasonably strong wood species available for structural applications and this has important economic and cultural implications.

Similarly, a diversity of non-wood forest products has also been available among various cultures around the world. There is much interest also in traditional knowledge from forests unique to particular societies around the world (for example basketry and other weaved products, tree bark products, traditional medicinal plant products, edible fungi, latex and extractives from trees, wildlife and fruits). Also the future availability of organic-based products from wood lignin, cellulose and hemicelluloses seems certain, eventually translating into new wood cultural experience to society for such new-generation forest-based products. While

mankind continues to explore, value and cherish a diversity of wood and other products from the forest as an intrinsic part of their lives, in time such sustained use and appreciation of these products would naturally become part of their cultural identity. The 2024 World Wood Day and Symposium theme “Diversity of Wood in Culture” celebrates the connection of wood and other forest-based products with people of different cultures.

## Topics

1. Historical Utilization and Trade and Cultural Values of Wood and Non-Wood Forest Products
2. Construction and Buildings Including Wood Durability and Protection Needs
3. Moveable Building Components, Furniture, Musical Instruments, Artefacts and Design
4. Education in Understanding Forest Products Culture and the Challenge of Climate Change
5. Protection and Conservation of Historical Wooden Properties including Related Forest Management, Craftsmanship, Traditional Wood Processing and Wood Working Experiences
6. Wood Products and Wood Biotechnology (IAWS Special Session)

# CATALOGUE

# 2024 World Wood Day Online Symposium Program

## Date: 21st-22nd March (UTC)

| Thursday, 21st March 2024 | | |
|---|---|---|
| **TIME** | **SUBJECT** | **SPEAKER** |
| 08:00-08:30 | Welcome and Opening Remarks<br>Group Photo | Dr. John Parrotta, President of International Union of Forest Research Organizations (IUFRO)<br>Dr. Howard Rosen, Chair of Internation Wood Culture Society (IWCS) and World Wood Day Foundation (WWDF)<br>Prof. Stavros Avramidis, President of International Academy of Wood Science (IAWS)<br>Dr. Yafang Yin, Executive Secretary of International Association of Wood Anatomists (IAWA)<br>Dr. Pekka Saranpää, Coordinator of IUFRO Division 5 Forest Products<br>Dr. Elisabeth Johann, Coordinator of IUFRO Unit 9.03.02 Forest Culture<br>Dr. Jürgen Kusmin, Forest Department, Estonian State Forest Management Centre (RMK)<br>Dr. Michael Grabner, University of Natural Resources and Life Sciences, Vienna (BOKU) / Editor in Chief of International Journal of Culture (IJWC) |
| | Topic 5. Protection and Conservation of Historical Wooden Properties including Related Forest Management, Craftsmanship, Traditional Wood Processing and Wood Working Experiences<br>Chair: Dr. Elisabeth Johann<br>Austrian Forest Association / Coordinator of IUFRO Unit 9.03.02 Forest Culture | |
| 08:30-09:00 | The 2017 ICOMOS Principles for the Conservation of the Wooden Built Heritage | Mr. Doug Evans<br>ICOMOS International Wood Committee |
| 09:00-09:20 | Principles of Indigenous *Kath-khuni* Building System in Himachal Pradesh, India | Mr. Rahul Bhushan<br>HPCDI North Institute (OPC) Pvt. Ltd. |
| | Topic 4. Education in Understanding Forest Products Culture and the Challenge of Climate Change | |
| 09:20-09:50 | Wood Culture and Traditional Forest Knowledge | Prof. Mauro Agnoletti<br>University of Florence |
| 09:50-10:10 | Nurturing Forests for Tomorrow: Embracing Climate Resilience through Sustainable Management | Sheikha Hend Faisal Al Qassimi<br>H.R.H. (Her Royal Highness) of Sharjah, United Arab Emirates |
| 10:10-10:25 | Coffee Break | |
| 10:25-10:45 | Elementals and Spectroscopy Evaluation of Milled Sawdust of Blighia Sapida, K. Koenig: A Lesser Known Timber Species Grown In Nigeria | Dr. Olusola Samuel Areo<br>Forestry Research Institute of Nigeria, Ibadan |
| 10:45-10:55 | The study of dendrochronology is crucial for Bran's oak (*Quercus brantii* Lindl.) in Zagros forests of Iran | Ms. Firoozeh Hatami<br>Forest Research Division, Research Institute of Forests and Rangelands, Agricultural Research, Education and Extension Organization, AREEO, Tehran, Iran |
| 10:55-12:00 | Lunch | |
| | Topic 6. Wood Products and Wood Biotechnology (IAWS Special Session)<br>Chair: Dr. Ingo Burgert<br>Institute for Building Materials, D-BAUG, ETH Zurich / IAWS Vice President | |
| 12:00-12:30 | The Frontier of Innovation: Wood Products and (Bio)technology for Sustainable Development | Prof. Rupert Wimmer<br>BOKU University, Institute of Wood Technology and Renewable Materials |
| 12:30-12:50 | Research and Development on Bamboo Properties and Bamboo Fiber-based Composites for Plastic Substitute | Dr. Ge Wang<br>International Center for Bamboo and Rattan |
| 12:50-13:10 | Improving Wood Quality for Pulping and Biorefining | Prof. Wout Boerjan<br>Dep. of Plant Biotechnology and Bioinformatics, Ghent University |

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| 13:10-13:30 | Wood Modification Based on In-situ Esterification of Pinus Sylvestris with Citric Acid and Sorbitol | Dr. Katarzyna Kurkowiak<br>Wood Biology and Wood products, Georg-August-University Göttingen |
| 13:30-13:45 | Coffee Break | |
| 13:45-14:05 | *BioGlue-Centre* 2024-2028: A New Competence Centre for Bio-based Adhesives in Sweden | Prof. Stergios Adamopoulos<br>Swedish University of Agricultural Sciences |
| 14:05-14:25 | Recent Research with Archaeological Wood: Identification and Analysis of Very Small or Particulate Material and Taxa with Anomalous Anatomical Structure | Dr. Lee A. Newsom<br>The Pennsylvania State University (Emerita) |
| 14:25-14:45 | Transforming Wood into a High-performance Engineering Material via Cellulose Nanocrystal Impregnation | Prof. Dilpreet Singh Bajwa<br>Montana State University |
| 14:45-15:05 | Transfer learning for predicting wood density of different tree species: Calibration transfer from portable NIR spectrometer to Hyperspectral imaging | Mr. Zheyu Zhang<br>College of Mechanical and Electrical Engineering, Northeast Forestry University/ Department of Wood Science, University of British Columbia |
| 15:05-15:25 | My Last Hurrah: A Quick Retirement Review and Wrap-up of my Research Results in Wood Science and Sustainable Biomaterials | Prof. Barry Goodell<br>Professor Emeritus Univ. Maine, & Professor-Retired Univ. Massachusetts University of Massachusetts and University of Maine |

## Friday, 22nd March 2024

| TIME | SUBJECT | SPEAKER |
|---|---|---|
| | Topic 3. Movable Building Components, Furniture, Musical Instruments, Artifacts and Design<br>Chair: Dr. Marie-France Thévenon, Unité de Recherches BioWooEB, CIRAD / Coordinator of IUFRO Research Unit 5.03.00 Wood Protection | |
| 08:00-08:30 | Mystical Joy of Wood: The Resonance of India's Musical Instruments | Prof. Sangeeta Gupta<br>Botany Division, Wood Anatomy Discipline, Forest Research Institute, Dehradun, India |
| 08:30-08:50 | Understanding Methodological Framework to Document, Record and Decode the Craftsmanship and Narratives in the Wooden Vernacular Furniture of India | Mr. Jay Rajesh Thakkar<br>CEPT University |
| | Topic 2. Construction and Buildings Including Wood Durability and Protection Needs | |
| 08:50-09:20 | The Non-Destructive Location and Assessment of Structural Timber | Mr. Robert Owen Demaus<br>Demaus Building Diagnostics Ltd, IHBC |
| 09:20-09:40 | Estimating Stiffness of Rubber Plantation Timber: A comparative study the Smart Thumper Application and the Universal Testing Machine | Dr. Khamtan Phonetip<br>National University of Laos |
| 09:40-10:00 | Protection of Wooden Cultural Heritage with a Novel Wood Preservative with Vegetal Extracts–Permethrin-azole Mixture | Dr. Antoine Robert<br>Groupe Berkem |
| 10:00-10:15 | Coffee Break | |
| 10:15-10:35 | Durability and Leaching Properties of Wood Treated with Slow Pyrolysis Liquid | Dr. Febrina Dellarose Boer<br>AgroParisTech, BioWooEB CIRAD |
| 10:35-10:55 | Perception and Potential of Species Used in the Construction of Traditional Houses in the Antsimo Antsinanana region of Madagascar | Ms. Lovarisoa Emmanuella Faramamiarimila<br>University of Antananarivo |
| 10:55-11:05 | Mass Timber Construction (MTC) - Prospects in India | Ms. Laqshika Patiyal<br>Dr. Y.S Parmar University of Horticulture and Forestry |
| 11:05-12:05 | Lunch | |
| | Topic 1. Historical Utilization and Trade and Cultural Values of Wood and Non-Wood Forest Products<br>Chair: Dr. Marta Domínguez Delmás<br>Naturalis Biodiversity Center | |

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| 12:05-12:25 | Unveiling the Health Potential of Some Philippine Endemic Plants: A Preliminary Investigation on Physico/Phytochemical Profile and Antioxidant Activity | Mrs. Maingelline B. Vivit<br>Mariano Marcos State University |
| 12:25-12:45 | Going with the Grain: Olneya Tesota for Comcaac Communities across the Desertscape | Mr. Mike Gray<br>Religious Society of Friends released to a ministry with Indigenous Peoples |
| 14:45-13:05 | Medicinal Plants Used by Isneg Community in Adams, Ilocos Norte, Philippines and their Conservation Status | Prof. Mae Ann R. Batuyong<br>Mariano Marcos State University |
| 13:05-13:20 | Coffee Break | |
| 13:20-13:40 | Material and Aesthetic Mediated Materiality of Digeridoo (Australia) and Bansari (India) | Mr. Harendrakumar Dave<br>Edith Cowan University (2004-2010), Part time Research Student |
| 13:40-14:00 | Time For Craft, Changing Woods: How Time Shapes Artisans' Work, How Ecological Crisis Changes Wood Uses in Musical Instruments Making | Dr. Iris Brémaud<br>Wood Team, LMGC, Univ. Montpellier, CNRS |
| 14:00-14:20 | The Culture and Craft of Wood Type | Prof. Helen Smith<br>University of York |
| 14:20-14:40 | The Hidden Potential of the Non Wood Forestal Products from the Bolivian Amazonia: The Asaí (Euterpes predatoria) Value Chain Upgrading through Regenerative Forestal Enterprises for Supporting People Living in Food Vulnerability | Dr. Eduardo López Rosse<br>Gobierno Autónomo Municipal de Cochabamba |

# Abstract

# Historical Utilization and Trade and Cultural Values of Wood and Non-Wood Forest Products

# Medicinal Plants Used by Isneg Community in Adams, Ilocos Norte, Philippines and their Conservation Status

**Mae Ann R. Batuyong*, Mena Jane Suniga, Jumaine Mauricio Fugiao, Maingelline B. Vivit, Franklin V. Ibana, Cecile A. Gaoat, and Michael A. Calaramo**
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## Abstract

One of the identified indigenous people (IPs) in the Province of Ilocos Norte originating from the Cordillera Region—the Isnegs who particularly have relied on indigenous traditional knowledge, medicinal plants, and ritual plants in treating non-chronic diseases, as well as practices that have passed down from generations. Hence, documenting the application of the plants used in the community is essential to preserve the knowledge as it has been part of the culture among Isnegs.

In this study, information on medicinal plants used by the Isnegs was obtained using a semi-structured interview followed by group discussions, field observations, and guided field walks with 30 key informants comprised of tribal chieftains, traditional healers, community elders, and IPMR. from the three barangays of Dumalneg, Ilocos Norte. The conservation status was assessed based on the international and national listing of threatened species. A Certification Precondition Permit No. IKSP-RO1-2023-10 and Ethics Review Board No. MMSU-2023-320 were obtained before the conduct of the study.

A total of 44 species belonging to 22 families were identified as ethnomedicinally important. There was strong agreement among the key informants regarding ethnopharmacological uses of plants for the diseases of the ear or mastoid process, with ICF values ranging from 0.95 to 1. Regarding the plant parts used, the leaves (54%) are the most used to treat different

kinds of ailments. Pounding (33%) is also the preferred preparation for medical undertakings. Conservation assessment revealed that two plants are endemic: *Alpinia haenkei* C. Presl and *Strobilanthes pauciflora* (Merr.) Y.F. Deng, under the family Zingiberaceae and Acanthaceae, respectively. *Swietenia mahagoni* (L.) Jacq was assessed as Near Threatened, and the remaining species as Least Concern, Not Determined, or Data deficient. The results of this study present the rich ethnomedicinal knowledge of the Isneg community, which could serve as a useful source of information to improve community healthcare and environmental conservation and management.

## Time for Craft, Changing Woods: How Time Shapes Artisans' Work, How Ecological Crisis Changes Wood Uses in Musical Instruments Making

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## Abstract

Woodcrafts are an essential part of wood culture, and craftsmanship recently attracts much interest, both in the life choices of individuals, and in the academic research focusing on crafts. Woodcraft involves several aspects of time, and of the related notion of change, that can be challenged by contemporary issues. The global acceleration of time in the late modern society can be difficult to reconcile with the temporalities of craftsmanship knowledge acquisition and of artisanal work. The acceleration of the biodiversity crisis threatens more and more numerous woods that are iconic in cultural uses. This ongoing project addresses the intertwining between dif-

ferent temporalities of contemporary craftwork, and several aspects of changes in wood used. The work combines multidisciplinary texts surveys, meetings and interviews with artisans, qualitative evaluation of wood, and quantitative characterization of material properties. Several woodcrafts are considered, yet given the topic of “diversity of wood in culture” for WWD2024, this talk will focus on two case studies that are particularly affected by the erosion of biodiversity, i.e. guitars- and bow-making. They show different trends regarding wood diversity, both in their historical trajectories, and in their contemporary situations. Socio-cultural, economical and ecological contexts can influence the degree of expectation for wood species and qualities, in various ways: “status-quo”, or increased exigence, or broader flexibility. The time of experience in working with a wood can build a faculty to anticipate its properties (including some long-term behaviors). The connection between artisans’ discourses and results from physical tests helps to better understand the craftsmanship qualification within a preferred species (for example in Pernambuco for bows). Iconic – but threatened – species such as Pernambuco and Rosewoods are compared to other species cited in guitar and bow crafts (a hundred species were tested in total). To illustrate some of the triggers and limitations of change in wood, “traditional” and “new” species are compared on the combined basis of their frequency of use in guitar-making, of their vibro-mechanical and optical properties, and of their conservation status.

# Material and Aesthetic Mediated Materiality of Digeridoo (Australia) and Bansari (India)

**Harendrakumar Dave**
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## Abstract

Literature survey reveals that only civilization explored their forest resources for their basic needs and also aesthetic attitude in creative activity. The aesthetic attitude can be seen from aborgines and early Indian (from India) people in their history of music, art and songs of religious ceremony and dance.

Use of windpipe, musical instrument is in use for at least 2000 years. What we can see today is the tangible material of the Digeridoo and Bansuri. What we cannot see and feel is the intangible value associated with it. Physical artifacts of corresponding time and place were used to find nearby hollow pipe of natural resources. Aborgines of North Australia found hollow pipe of natural resources of termite infected eukalyptics in the North Australian Forest. Only Indian people found bamboo from Himalayan Forest. Blowing air with the help of mouth in this hollow pipe generated resonating and created pleasing sound which became part of their material culture. Agentitive network was established and became the part of religious ceremonies. Still, today its use is increasing among Aborgines people of Australia and people in India.

However, the physical form of Digeridoo and Bansari have been changed. This is due to the effect of contribution of development in material science and understanding physics of it and creative activity of people in general. The aesthetic properties of sound generated by both instruments have increased demand in international market.

These links material properties ----- intangible materiality ---- sustainability

**References**

1. McCarthy, F.D; Mankind, Vol. 2 No. 8 (1940)
2. Falconer, J. (1993), fao.org
3. Werner, P.A, et al Forest Ecology and Management 256, 3 (2008)

## Going with the Grain: Olneya Tesota for Comcaac Communities across the Desertscape

**Mike Gray**
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## Abstract

This work outlines the historical, cultural, spiritual, and scientific uses and approaches of Ironwood (Olneya Tesota) and various forms of plant life as utilized through the Comcaac (Seri) Communities for cultural productions. Outlining the emergence of this work through the visions and dreams of Jose Astorga and the robust art movement to follow, Gray will lead us through a history of wood creations and their meaning to the Comcaac (Seri) people. Ironwood is a unique entity that has immediate, recognizable and international representation to this small and isolated community. This discussion also works to create conversations around conservation of the desert and creations from this community as symbols of cultural pride for continuity. The Comcaac (Seri) use their agency as Indigenous artists to create the version of themselves that they wish to display the world. The Comcaac (Seri) Community as Gray will discuss, has utilized wood for generations creating knowledge that has been transmitted and now shared in

a global platform connecting others who respect and collaborate with the living world around them. Gray will lead us through economic development of the Seri communities and how their manifesting the dream of Astorga continues to have a significant monetary impact for the communities today. Like many tribal communities, the Comcaac (Seri) peoples continue to maintain their traditions in an ever changing landscape. Issues of deforestation, climate change, and development culture also shift our conversations to one of accessibility to plant life and the knowledge behind them. This discussion will draw from recent primary source interviews with the Comcaac people by the International Wood Culture Society. In conclusion, this discussion leads us through historical context and the legacies of Comcaac (Seri) Artists and how they envision and create their futures.

## The Hidden Potential of the Non Wood Forestal Products from the Bolivian Amazonia: The Asaí (*Euterpes predatoria*) Value Chain Upgrading through Regenerative Forestal Enterprises for Supporting People Living in Food Vulnerability

**Eduardo López Rosse**
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## Abstract

Predatory practices deforested the Amazonian forest during the last hundred years driving into de landscape changing and endangering native species. The identification of noble Non Wood Forestal Products (NWFP) such as the Asaí (*Euterpe precatoria*) which was exploited through cutting the whole palm, but now with the intervention of technical service providers, this trend was changed into a more sustainable fruit collection. The legal

framework in the Bolivian scenario for industrialization of Amazonian fruits is a turning point which helped to implement three model processing plants in Pando encouraging sustainable collection of Asaí and other Amazonian fruits (almonds, peyibaye) according to the season. In this study, the value chain map was used as an instrument to identify all actors involved in the Asaí value chain. In spite of the present legal framework for ensuring food security for vulnerable populations (children, pregnant women and elders), Amazonian products such as Asaí are oriented to be exported overseas (processed products) and for national markets (pulpa) to the preparation of fancy desserts commercialized in the richest neighborhoods of the principal cities in contradiction to the Law No 765 Eating Well and the Law No 622 on public policies for school foods. This study shows how extraordinary foods in nutritional values are diverted to foreign markets instead of accomplishing overall objectives such as the Sustainable Development Goals (SDG) number 1 eradication of poverty and number 2 zero hunger among the most important. The role of public enterprises in the Bolivian context such as EMAPA and EBA play and important task delivering these Amazonian fruits to vulnerable populations but some strategies are required to fulfill the SDG further.

## The Culture and Craft of Wood Type

**Helen Smith**
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## Abstract

Invented in China in or around 1040 CE, wood type began to be widely used in the nineteenth century, particularly for poster printing and advertising

materials. Wood type manufacturers in the US, Britain, and Europe produced a huge variety of designs and alphabets, including Cyrillic, Burmese, German blackletter, Hebrew and Chinese pictograms. Research into wood type has to date focussed primarily on the history of wood type in the US, and on catalogues and specimens, along with the history of particular manufacturers. This paper will draw on important recent research into the colonial histories of print, paper and bureaucracy to argue for the entangled global histories of wood type. It will explore the materiality of wood type as a product of global trade and the commercial exploitation of hardwoods, and as a means to navigate and express colonial relationships, translation and communication across languages. Taking DeLittle of York, the UK's last wood type factory, as a case study, the paper will trace the varied cultures of wood type, and the craft associated with its materials, design, manufacture and use, as it travelled from forest to factory, and on to customers both local and international. The paper will explore DeLittle's relationship to ideas of Britishness and national identity, including through its 'Empire' border, royal printing, and the distinctive 'white letter' Eboracum face, named after Roman York. It will briefly discuss DeLittle's creation of a unique pantograph, allowing letters and other forms to be cut in two sizes at once from a single pattern, and will trace the journeys of DeLittle-created typefaces including Cyrillic, Gaelic, Tamil and Sinhalese. The paper will conclude with a brief account of the artist's residency funded by the World Wood Day Foundation, showing how these themes have been interpreted and given new creative life.

# Unveiling the Health Potential of Some Philippine Endemic Plants: A Preliminary Investigation on Physico/ Phytochemical Profile and Antioxidant Activity

**Maingelline B. Vivit*, Kevin M. Lorenzo, Alondra T. Fae Damian, Violeta Taroma, Rejhine Ortega, Jamie Cabuntocan, Anabelle B. Alejo, Kristian Gay D. Beltran, Elpidio P. Cadalzo, Michael A. Calaramo, Cecile A. Gaoat, Franklin V. Ibana, and Mae Ann R. Batuyong**
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## Abstract

This study pioneered the investigation of the physicochemical profile, phytoconstituents, and antioxidant activity of Philippine endemic plants namely: are *Ixora bibracteata Elmer* (IBLE), *Guettardella microphylla* (GMLE), *Timonius ternifolius* (TTLE), *Neonauclea reticulata* (NRLE), *Neonauclea bartlingii var. cumingiana* (NBLE), *Psychotria palimlimensis* (PPLE), *Kanapia monstrosa* (KMLE), and *Pyrostria trifolia* Arriola, Calaramo & Alejandro and (PTLE). The leaves were analyzed for physicochemical characteristics following standard protocols. Phytochemical analysis was conducted using liquid chromatography-mass spectrophotometry (LC-MS). The crude extract's total phenolic (TPC), flavonoid (TFC), and terpenoid (TTC) contents were estimated using Folin-Ciocaltaeu, aluminum chloride, and gravimetric methods, respectively. Antioxidant activity was assessed through 2,2-diphenyl-1-picrylhydrazyl radical (DPPH) scavenging assay.

Results of the organoleptic observations show that the dried leaf plant samples were olive to dark grayish. Moisture content ranged from 50.07 to 61.07% with pH levels of strong to very strongly acidic in 1% and 10% aqueous solutions. High extractable matter can be derived from IBLE, TTLE, KMLE, and PTLE with 80% methanol. GMLE, requires 95% methanol for high

yields, while NRLE, NBLE, and PPLE are best extracted with water. LC-MS analysis tentatively identifies 15 compounds from IBLE, 15 from GMLE, 12 from TTLE, 10 from NRLE, 23 from NBLE, 7 from PPLE, 14 from KMLE, and 23 from PTLE that were associated with numerous pharmacological properties. GMLE showed the highest TFC (0.320±0.05mg QE/g, DW) followed by KMLE (0.311±0.007 QE/g, DW). On the other hand, IBLE showed the highest TPC (3.64±0.08mg GAE/g, DW), while TTLE on the highest TTC (6.071±0.53 mg/g, DW). Moreover, the majority of the samples except for KMLE showed strong and potent antioxidant activity. Thus, the plant samples were promising natural antioxidants. Moreover, the identified compounds imply broader pharmacological applications which warrant further exploration.

# Construction and Buildings Including Wood Durability and Protection Needs

# The Non-Destructive Location and Assessment of Structural Timber

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## Abstract

Timber is the one material that was common to almost every historic construction, whether as floors and roofs in predominantly masonry buildings, or as the main building material.

It is also the common building material most vulnerable to the agents of destruction, including insects, fungi and fire.

Structural timbers that appear to be by visual inspection to be in good condition can be severely degraded beneath the surface. Conversely, timbers that appear to be severely degraded by visual assessment often retain sufficient strength to be kept and conserved. Too frequently, timbers that should be repaired or replaced are missed, but even more often, timbers that should be retained and conserved as part of a historic structure are lost.

This presentation will discuss and illustrate some of the non-destructive techniques that can be used to locate, identify and assess structural timbers in historic buildings.

# Durability and Leaching Properties of Wood Treated with Slow Pyrolysis Liquid

**Febrina Dellarose Boer[1,2,3]*, Luc Pignolet[1,2], Jérémy Valette[1,2], Kévin Candelier[1,2], Jean-Michel Commandré[1,2], Mériem Fournier[3,4] and Marie-France Thévenon[1,2]**

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## Abstract

The slow pyrolysis method offers a sustainable way to convert residual agricultural biomass into energy-dense biochar along with its by-product, pyrolysis liquid, for diverse applications. Due to its high concentration of bioactive chemicals, pyrolysis liquid has gained interest, including its potential as a wood protectant. This study aims to evaluate the efficacy of slow pyrolysis liquid from sugarcane bagasse for wood protection against fungi and termites, as well as its water-leaching properties. Pyrolysis liquid was obtained from slow pyrolysis of sugarcane bagasse at 500 °C temperature, 10°C/min heating rate, and 60 min of holding time. Samples of beech and pine wood were impregnated with pyrolysis liquid using different concentrations and dried at different drying temperatures. Results showed that higher drying temperature (103 °C) resulted in agglomeration of pyrolysis liquid inside wood cells and lower the leaching rate. Nonetheless, no chemical reaction was observed in FTIR tests. The pyrolysis liquid effectively repelled termites and act as a toxic agent at a 25% concentration, while

higher concentrations (50% and 100%) were needed to protect against certain types of Basidiomycete fungi (Coniophora puteana and Rhodonia placenta, cubic rots and Trametes versicolor, a fibrous rot). However, the pyrolysis liquid remained leachable when exposed to water and high humidity, in which 3-methyl-1,2-cyclopentanedione, 2,6-dimethoxyphenol, and phenol were found to be the most significant compounds that leached from all the treated wood. Further study is worth carrying out, particularly in investigating the formulation strategies to improve fixation for extended efficacythrough-life and minimize the impacts on human health and the environment.

**Keywords**: biomass, fungi, leaching, pyrolysis liquid, sugarcane bagasse, slow pyrolysis, wood protection, termites

## Perception and Potential of Species Used in the Construction of Traditional Houses in the Antsimo Antsinanana region of Madagascar

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## Abstract

Traditional housing in Madagascar vary in structure and setting, influenced by local culture, environment, and climate. However, the use of wood in traditional housing construction contributes to forest degradation in the country, as wood is readily available and frequently used. This practice is

further exacerbated by illegal selective logging, which leads to the disappearance of species that have important ecological roles. The annual consumption of wood and the durability of the construction are highly dependent on the species chosen. To tackle this problem, this study aimed to identify the most commonly used species in traditional housing construction and understand the reasons behind these choices. The results of the survey of 145 households in the Antsimo Antsinana region revealed that *Cleistantopsis* sp, *Syzigium* sp, *Streblus dimepate*, *Carissa edulis*, *Eucalyptus* sp, *Tambourissa* sp, *Cleistantus boivinanus*, *Homalium* sp, *Harungana madagascariensis*, *Acacia* sp are among the 10 species most commonly used in construction. The reasons for this choice are based on perceived durability (12.41%), strength (71.03%) and straightness (37.24%), as well as economic considerations (20.69%), with people favouring the most affordable species. Using Near Infrared Spectroscopy (NIRS) technique on samples of these 10 species, we were able to determine the physical and mechanical properties of the wood, its density and mechanical strength, as well as estimating its natural durability. The results showed that only half of the species tested matched people's perceptions. It is therefore crucial to gain a better understanding of wood's potential in order to determine people's needs based on their perceptions, and to propose alternatives with similar characteristics for the balanced and sustainable management of forest resources

**Keywords**: housing construction, forest, perception, wood proprieties, wood consumption, sustainable

# Protection of Wooden Cultural Heritage with a Novel Wood Preservative with Vegetal Extracts–Permethrin-Azole Mixture

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## Abstract

The worldwide cultural and technical heritage is made up of several materials but a considerable portion of it is partly or entirely made of wood. We can list all types of wooden buildings, other wooden structures that have cultural significance or are parts of historic places, and includes temporary, movable, and evolving structures, but also pieces such as artefacts with several components.

Their intrinsic cultural and historical value makes their preservation an absolute prerequisite. Restoration of surfaces against mold, and/or insects, termites require expertise of restorers/conservators.

An environmentally conscious society in Europe and other economically developed regions requires that wood protecting chemicals contain lesser or lower levels of synthetic actives and be supplemented instead with bio-based ingredients to enhance the bioefficacy of the treatment formulations. With expertise and knowledge in biocidal formulations, especially for wood preservation for over 60 years, Groupe Berkem patented bio-based formulations based in part on pyrethroid-azole-vegetal extracts mixture (SYNERKEM® technology with polyphenols). These solutions have already been evaluated as promising eco-friendly and cost-effective new genera-

tion wood preservatives for aboveground indoor and outdoor wood protection against termites in Malaysia.

The paper presents recent treatment experiences in Europe for the preservation of cultural heritage with the bio-based gel-emulsion XILIX® containing SYNERKEM® technology, whose higher diffusion capacity has been proven (up to 8 mm pyrethroid penetration into the wood). Eight cultural sites located in Bulgaria, Czech Republic, France, Hungary, Slovaquia and treated up to ten years ago are described including churches, cathedrals, palaces renovated into hotels, castles. Both insect and fungi damages were observed. The matrix “wood” revealed to be well protected.

Therefore, the bio-based fungicide and insecticide gel emulsion is of advantage to restoration of wood pieces with only one product. And its use in envelope treatment leads to a greener future for wooden cultural heritage protection.

# Estimating Stiffness of Rubber Plantation Timber: A comparative study the Smart Thumper Application and the Universal Testing Machine

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## Abstract

This study aimed to examine the accuracy of estimating the modulus of elasticity (MOE) of rubber plantation timber using both the SMART THUMPER™ application and the universal testing machine. The results indicated that there was no significant difference between the MOE values obtained from the two testing methods, as determined by a P-value of 2.06 (P>0.05). Specifically, the average MOE for the universal testing machine was calculated to be 10048±2610 MPa, while for the Smart Thumper App, it was 10155±2415 MPa. To further enhance the findings, it is recommended to conduct additional experiments involving groups of specimens with defects and clear specimens.

# Mass Timber Construction (MTC) - Prospects in India

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## Abstract

The building and construction sector is a major contributor to human environmental impact on the planet. Worldwide the construction industry is a major source of anthropogenic pollutants through the use of primary energy, emissions of greenhouse gases (GHGs), extraction of non-renewable raw materials, and generation of construction and demolition (C&D) waste. Of the global carbon emissions, the building operation and the manufacturing of construction materials sectors account for 28% and 11%, respectively along with 40% of total carbon emissions. Mass timber products, are one of the sustainable alternatives to traditional building materials and have led to the recent revolution in timber construction. Mass timber (MT) is a group of engineered wood products developed to combat the limitations imposed by small dimensions, dimensional instability, and variability of wood. Cross Laminated Timber (CLT), Glue laminated timber (Glulam), Laminated Veneer Lumber (LVL), Dowel Laminated Timber (DLT), and Mass Plywood Panel (MPP) are typical MT products. Utilizing MT products as alternatives to conventional non-renewable building materials can help alleviate the increasing global environmental issues such as global warming and energy depletion. To illustrate, the energy consumption of timber-based building is about 15% less compared to conventional buildings. This is because of the reduced energy required for wood production compared to the manufacturing of conventional building materials (concrete and steel) that are obtained through the non- renewable sources. India with its growing population, infrastructural need and sustainability, has a huge potential to successfully adopt MTC.

# Moveable Building Components, Furniture, Musical Instruments, Artefacts and Design

# Mystical Joy of Wood: The Resonance of India's Musical Instruments

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## Abstract

Music has always been the fascination of early man. Musical instrument are tools of human expression that reveal historical, technological, social, and cultural aspects of times and people.

Wooden musical instruments have played a significant role in India's musical heritage across various eras. Throughout history, craftsmanship and playing techniques have been passed down through oral traditions and apprenticeships. India's musical landscape reflects a rich tapestry of traditional and contemporary instruments, each with its unique cultural and artistic significance.

In India, the combination of wood features is carefully considered by instrument makers to achieve a harmonious balance between durability, resonance, and tonal characteristics. The choice of wood is based on specific requirements of each instrument and the musical tradition it represents. Woods preferred are Artocarpus species (Jackwood), Santalum album (Sandalwood), Tectona grandis (Teak), Toona ciliata (Toon), Sweitenia species (Mahogany), Picea (Spruce), Acer species (maple), Dalbergia sissoo (Sheesham), Dalbergia latifolia (Rosewood), Pterocarpus dalbergioides (Padauk), Juglans regia (Walnut) and Bamboos. The choice of wood also reflects regional preferences and the availability of species.

The features/anatomy of wood directly impact its acoustic properties, which are vital for achieving the desired sound quality in instruments. Fea-

tures considered are density, hardness, grain orientation, pore structure, dimensional stability, and durability.

In today's scenario, sourcing the preferred material is a challenge, therefore instrument makers are exploring alternatives, prioritizing responsible sourcing, and adapting their craft to ensure that the instrument produced maintain desired qualities.

## Understanding Methodological Framework to Document, Record and Decode the Craftsmanship and Narratives in the Wooden Vernacular Furniture of India

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## Abstract

Vernacular furniture is used in everyday life of people of a particular region or community. It is made by traditional craftspeople using locally available materials. Most of the vernacular furniture is made of wood and plant materials like bamboo, rattan, and rope. In a country like India, where the vernacular fabric changes every few hundred kilometres, a region's architecture, interiors and furniture are excellent examples that reflect several social and cultural aspects of that particular region. Though this regional furniture has played an essential role in the lives of the people of India for centuries, there needs to be more holistic and systematic research on this material culture.

This paper will showcase the framework and methodology that was developed to discover and decode the vernacular furniture as part of the

first-ever research project called 'Vernacular Furniture of North-West India,' conducted by Design Innovation and Craft Resource Center (DICRC), CEPT University, and The South Asian Decorative Arts and Crafts Collection Trust (SADACC), UK.

A detailed methodology and framework were developed to find the vernacular furniture, which comprises four major stages: 1) identifying and locating the vernacular furniture, 2) recording stories, 3) analysing the crafts, and 4) using the collection. The framework used two disciplines as trajectories to study the wooden vernacular furniture - anthropology and design. Using an anthropological perspective, we recorded diverse stories about the region, people, vernacular furniture, craftspeople, and socio-cultural narratives. The details of how they crafted and made things were only preserved through oral histories. We prepared detailed furniture drawings on the field to decode these encoded data. We also had further discussions with craftspeople and recorded the craft processes, which helped us in the process of making.

Through systematic primary research, our team were able to identify, map, document and record more than 6000 pieces of vernacular furniture in North West India. This paper discusses the diversity of wooden vernacular furniture, its association with India's crafts and cultural heritage, and its position in present-day development trajectories. Further, it will delve into the narratives and craftsmanship associated with selected wooden furniture through the lens of anthropology and design.

**Keywords**: Vernacular Furniture, Traditional crafts, Oral Narratives, Indian Culture, Documentation Framework, Wooden craftsmanship
website: https://vernacularfurnitureofindia.com/

# Education in Understanding Forest Products Culture and the Challenge of Climate Change

# Nurturing Forests for Tomorrow: Embracing Climate Resilience through Sustainable Management

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## Abstract

**Introduction:** Hey there! Imagine taking a stroll through a lush forest, breathing in the fresh air, and listening to the gentle rustle of leaves. It's a beautiful scene, right? But did you know that forests are facing tough times due to climate change? Don't worry, though! In this article, we're diving into how sustainable forest management can help our beloved forests weather the storm of climate change and thrive for future generations.

In the serene expanse of a forest, where the air is crisp and the foliage dances in harmony with the breeze, lies a crucial battleground in the fight against climate change. As we convene to address the pressing challenges of our time, it's imperative to recognize the pivotal role of sustainable forest management in safeguarding our precious ecosystems for generations to come. In this article, we delve into the transformative potential of sustainable practices in fostering climate resilience and preserving the invaluable services provided by forests.

**Understanding Climate Change Impacts on Forests:** Climate change has unleashed a barrage of challenges upon our forests, threatening their very existence. From the scorched landscapes of California's wildfires to the dwindling habitats of endangered species, the impacts are stark and sobering. As temperatures rise and rainfall patterns become increasingly erratic, forests are left vulnerable to drought, pest infestations, and catastrophic fire events. It's a stark reminder of the urgent need for proactive measures to mitigate these threats.

**Principles of Sustainable Forest Management:** Enter sustainable forest management – a beacon of hope amidst the turmoil. At its core, sustainable forest management embodies the principles of stewardship, balance, and resilience. By adopting holistic approaches that prioritize ecological integrity and long-term sustainability, we can strike a harmonious balance between human needs and the conservation of forest ecosystems. It's a paradigm shift from exploitation to coexistence, from short-term gains to enduring prosperity.

**Adaptive Strategies for Climate Change Adaptation:** Adaptation is the name of the game when it comes to climate resilience. Sustainable forest management offers a repertoire of adaptive strategies to bolster the resilience of forests in the face of climate change. By embracing biodiversity, favoring climate-resilient species, and implementing innovative silvicultural practices, we can fortify forests against the onslaught of environmental stressors. Take, for instance, the success story of Costa Rica, where agroforestry initiatives have revitalized degraded landscapes, enhancing both ecological resilience and livelihoods.

**Integrated Landscape Approaches:** Yet, forests do not exist in isolation – they are integral components of broader landscapes encompassing agriculture, water resources, and human settlements. Integrated landscape approaches offer a holistic framework for optimizing land use, enhancing connectivity, and fostering synergies between conservation and development objectives. Consider the pioneering efforts in the Brazilian Amazon, where landscape restoration projects are transforming degraded lands into vibrant ecosystems, bolstering resilience and fostering sustainable livelihoods.

**Community Engagement and Indigenous Knowledge:** Central to the success of sustainable forest management is the active involvement of local communities and the recognition of indigenous knowledge systems. Indig-

enous peoples, with their deep-rooted connections to the land, offer invaluable insights into adaptive strategies for climate resilience. By honoring and amplifying indigenous voices, we can tap into a wealth of traditional knowledge about forest stewardship, ecosystem management, and resilience-building. It's a testament to the power of collaboration and cultural diversity in charting a course towards a sustainable future.

**Investing in Resilient Forests for Future Generations:** As we stand at the crossroads of history, the imperative to invest in resilient forests has never been clearer. Sustainable forest management is not just an environmental imperative – it's an investment in our collective well-being. From carbon sequestration and watershed protection to biodiversity conservation and livelihood support, forests provide a myriad of ecosystem services that underpin human prosperity. By prioritizing sustainable practices, we're not only securing the future of forests but also safeguarding the health and resilience of our planet for generations to come.

**Conclusion:** In the tapestry of life on Earth, forests are the threads that bind us together – sustaining ecosystems, nourishing communities, and inspiring wonder. As we navigate the uncertainties of a changing climate, let us heed the call to action and embrace sustainable forest management as a cornerstone of our collective resilience. By nurturing forests for tomorrow, we honor our commitment to future generations, ensuring that the timeless beauty and vitality of forests endure for millennia to come. By embracing sustainable forest management practices, we can nurture resilient forests that stand tall against the challenges of climate change. So, whether you're a tree hugger, a nature lover, or just someone who enjoys a good hike in the woods, let's join hands and work together to ensure that forests continue to thrive for generations to come.

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## Elementals and Spectroscopy Evaluation of Milled Sawdust of *Blighia Sapida*, K. Koenig: A Lesser Known Timber Species Grown in Nigeria

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## Abstract

Deforestations of tropical forests due to demands by increasing population have rendered the wood sector non-productive in view of a decrease in the availability of the commercials timber species. In ensuring adequate supply and availability of timber in the wood industry, *B.sapida*, a Lesser-Used Species, is being processed into sawn timber. Knowledge of its chemical composition will further improve its utilization potential. Due to insufficient scientific information on the chemical properties of the wood, investigation into its chemical composition becomes imperative to harness its utilization potential. Three standing trees of *B.sapida* were felled for this study at the Campus of University of Ibadan, Nigeria. Billets of 50cm were collected from the base, middle, and top of merchantable height of each tree following the ASTM 1666-87 standard procedure. Sawdust was collected from the base, middle and top of each tree as test samples for the determination of chemical composition analysis of the wood such as (cellulose, hemicellulose, lignin and silica content). The results showed the average percentages chemical constituents of 1% NaOH, Hot water, and cold water were highest at the base (9.23±0.09, 6.47±0.09, 5.03±0.09) and lowest at the middle (8.43±0.09, 5.87±0.09, 4.37±0.09) respectively. Cellulose and lignin were highest at the base (40.97±0.88, 18.53±0.15) and lowest at the top (38.33±0.88, 16.73±0.88) respectively. However, hemicellulose was highest at the top (30.47±0.88) and lowest at the base (24.57±0.88). An extractive element shows that the silica content was highest at the base (0.83±0.03) and lowest at the top (0.47±0.03). Hence, the chemical composition and extractive contents suggest its suitability for pulp and paper production.

**Keywords**: *Blighia sapida*, extractives, composition, hemicelluloses, pulp production

# The study of dendrochronology is crucial for Bran's oak (*Quercus brantii* Lindl.) in Zagros forests of Iran

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## Abstract

Iran is a country with diverse climatic conditions, ranging from humid in the Hyrcanian forests to dry in the lifeless parts of the Lut deserts. This country has about 12.4 million hectares of forests, which is relatively poor compared to other parts of the world but is unique in terms of the diversity of plant species, with 8000 species and plant genetic reserves. However, due to its natural and geographical conditions, this area is often referred to as a bridge between the vital climates of the world. Iran has five ecological regions, including Hyrkani, Arsbaran, Irano-Turani, Zagros, and Persian Gulf-Omani. Zagros forests, which cover an area of approximately 5.4 million hectares, are one of the most important natural habitats of Iran. They are the origin of the valuable species of Bran's oak (*Quercus brantii* Lindl.) in the west of Iran and represent 42% of Iran's forests. The main cover of these forests is oak species which play a significant role in the ecological balance, soil, and water conservation of this region, as well as the socio-economic conditions of its residents. Dendrochronology is a technique of identifying and quantifying environmental processes by dating the annual growth layers of trees. Oak species in these forests have distinct growth rings, wide distribution range, dominant positions and are highly responsive to climate changes, making them suitable for tree chronology studies

and *Q. brantii*, with a dominant area of about 3.5 million hectares, is valuable for dendrochronological studies. Oak species, specifically *Q. brantii* as an excellent climatic indicator, in Zagros forests, can be used for Climate reconstruction, decline, history, archeology, and growth changes.

**Key words**: Iran, Zagros forests, *Quercus brantii* Lindl., Dendrochronology, Climate reconstruction

# Protection and Conservation of Historical Wooden Properties including Related Forest Management, Craftsmanship, Traditional Wood Processing and Wood Working Experiences

# The 2017 ICOMOS Principles for the Conservation of the Wooden Built Heritage

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## Abstract

In a session of the 19th General Assembly of the International Council on Monuments and Site (ICOMOS) held in Delhi on 15th December 2017, a new and updated Principles for the Conservation of the Wooden Built Heritage was adopted as an ICOMOS doctrinal text. Ever since the ICOMOS International Wood Committee was established in 1975, the need for a set of conservation principles has been a continuous theme in the Committee's ongoing discussions and activities. The first Principles for the Preservation of Historic Timber Structures was adopted by ICOMOS at the General Assembly in Mexico in October 1999. The presentation will look at the main reasons that led to the revision of the Principles including: recognising a wider variety of wooden heritage including its intangible side; to better recognise the diversity of cultural heritage and the subsequent diversity of approaches, and therefore to reflect the Nara Document on Authenticity (Japan 1994); and to update and adapt its content to present day concerns, knowledge and processes.

# Principles of Indigenous *Kath-khuni* Building System in Himachal Pradesh, India

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## Abstract

The Himalayan mountains have diverse geographical and climatic conditions and a rich cultural heritage. The responses in the built environment are distinct and specific to their location and people. Various indigenous building practices have evolved in the region using locally available materials like wood, stone, slate, mud, bamboo and more. These vernacular techniques and crafts present a high level of seismic design, climate resilience, and carry the cultural values of their respective regions.

In the Western Himalayas, the *Kath-Khuni* building system is an indigenous building system that is built using locally available wood and stone. This building system has evolved over thousands of years by the way of empirical practices and respond to contextual demands most efficiently. In *Kath-Khuni* buildings, wood is used for the structural framework. Walls are made with alternate layers of horizontal wooden beams infilled with dry stone masonry without the use of mortar. This building system embraces a composite wall system with wooden joineries.

Wooden structures are known for high resistance to earthquakes due to wood's high strength to weight ratio and its ductility. The fibres of wood make it highly effective in withstanding tensile stresses. In contemporary global architecture trends, timber is a rapidly upcoming building material due to its various advantages that include the binding of carbon dioxide, low embodied energy, fire safety etc.

In *Kath-Khuni* buildings, native tree species such as *Deodar* (*Cedrus deodara*), *Rai* (*Picea smithiana*) and *Kail* (*Pinus wallichiana*) are used. These species are found growing at an altitude roughly between 1600m and 2000m ASL, and *Kath-khuni* architecture can also only be found at this altitude.

This research work investigates the building system of *Kath-khuni* buildings in Kalpa, Kinnaur, Himachal Pradesh, in order to understand the detailed process of construction, along with the roles and responsibilities of local craftspeople in the making of these buildings. Through investigation and in-depth analysis, 6 fundamental principles of *Kath-khuni* building system are identified.

The region and its typical house-form are discussed. A *Kath-khuni* house, which is measure drawn to co-relate the narratives of craftspeople, is presented through the drawings. The analysis takes into consideration the knowledge of craftspeople and the system is analysed in terms of elements of a building, its parts and components, and role of craftspeople in the making process. While investigating the making of the built form, findings reveal the knowledge with which wood was employed and mastered, the techniques that were incorporated in the process of building, and the 3 logic behind the method that was then the tradition. The making clearly defines the relationship of the parts, the way they come together in an assembly, the potential and virtue of wood as a building material, the assembly of building system, the construction techniques that shaped it, and so on.

The fundamental principles of *Kath-Khuni* building system are applicable in the contemporary context of protection and conservation of historical wooden properties and related forest management, craftsmanship, traditional wood processing and woodworking experiences. The study and analysis of these wooden structures also provide insights on historical utilisation and cultural values of Wood from the Himalayas, as well as on con-

struction and building systems that include wood durability and protection needs.

# Wood Products and Wood Biotechnology

# (IAWA Special Session)

# The Frontier of Innovation: Wood Products and (Bio)technology for Sustainable Development

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## Abstract

This presentation explores the intersection of wood science and (bio)technology, shedding light on how these disciplines converge to foster innovative solutions in sustainable materials development. As global emphasis on environmental sustainability intensifies, the innovation in wood products emerges as a pivotal arena for research and development. We delve into a few of the latest advancements in engineered wood products, highlighting how innovative approaches—such as enzyme-based processes or mycological-modifications, are potentially revolutionizing properties and functionalities of wood-based materials. These advancements not only enhance wood's inherent qualities, such as material strength or bonding, but also provide novel characteristics, including improved fire resistance, or a reduced environmental impact.

This contribution examines the development of bio-based composites, showcasing their potential to replace non-renewable materials in various industries, with potential applications in the construction sector. Optimizing wood processing also means reducing waste through more efficient use of raw materials, emphasizing circular economy and reducing the carbon footprint of wood products.

The conclusion is a forward-looking perspective on the role of innovations in wood products and technologies to achieve sustainable development goals. By harnessing the synergies between wood science and (bio)technology, the question arises how can we unlock new pathways for

creating eco-friendly, renewable, and high-performance materials that meet the demands of a rapidly changing world? Overall, there is a need for cross-disciplinary collaboration to ensure that these innovations are sustainable, economically viable, and socially acceptable.

## *BioGlue-Centre* 2024-2028: A New Competence Centre for Bio-based Adhesives in Sweden

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## Abstract

The *BioGlue-Centre* is a network of excellence in Sweden in the field of bio-based adhesives in co-operation with 3 universities and 12 companies from different industrial sectors (furniture, construction, packaging), sharing the same research questions around adhesives and bonding. The Centre responds to the urgent need in these sectors to become more sustainable by increasing the speed of finding bio-based alternatives to the vast amounts of the, almost exclusively, fossil-based adhesives used today. These sectors alone consume about 25% of all adhesives produced worldwide, and thus represent a major market share. The substitution of fossil-based adhesives with bio-adhesives has hitherto not been possible since there is a lack of fundamental knowledge to create high-performing and more environment-friendly products. The vision of the Centre to become a world leading research environment will be accomplished through development of paradigm-shifting knowledge on bio-based adhesives in three research areas: raw materials and formulations, aspects of adhesives, and end-use requirements and sustainability. Such a research environment,

focusing on adhesives and adhesive function, does not exist today at international level. The Centre provides a unique opportunity to strongly influence novel research directions and revolutionise the field of bio-adhesives, thus bringing about several benefits for the involved partners and contributing to a more sustainable industry.

## Transforming Wood into a High-performance Engineering Material via Cellulose Nanocrystal Impregnation

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## Abstract

Wood has been an indispensable multipurpose material for ages. The increasing population has created a strong demand for wood as a construction material, resulting in shortages in the availability of high-strength wood. To meet the growing demand for high-strength wood products, softwood varieties that are weak for advanced engineering applications can be modified using cellulose nanocrystals (CNC) to enhance engineering properties. CNCs are abundantly available, lightweight, transparent, have high crystallinity, excellent mechanical properties, and are relatively low cost. In this research, a novel methodology was employed to enhance the mechanical properties of southern yellow pine wood through a combination of delignification and impregnation with surface functionalized-cellulose nanocrystals. The process included the delignification of SYP was performed using sodium hydroxide (NaOH). Subsequently, a CNC nanosuspension, functionalized with acetic acid (AA) and benzoic acid (BA), was mixed with the delignified wood. The wood samples were then ultra-

sonicated in the CNC nanosuspension, followed by vacuum pressure treatment.

The results from physical and mechanical tests on the treated wood demonstrated the ability of cellulose nanocrystals to generate high-performance materials from softwood. Atomic force and scanning electron microscopy confirmed the presence of CNC in the wood. The CNC treated samples had a smoother surface than the untreated samples, suggesting a more uniform microstructure and improved mechanical properties. The density of the treated SYP increased up to 30%. The mechanical test results (using ASTM D1037 and D2339 standards) and statistical data analysis revealed significant improvements in the mechanical properties of the treated wood. There was a remarkable increase of up to 110% in bending stiffness (modulus of elasticity, MOE) and up to 86% in bending strength (modulus of rupture, MOR). CNC treatment made wood susceptible to water absorption. Acetic acid treatment was more effective than benzoic acid. Overall, the study demonstrated that wood properties can be engineered by impregnating the CNC into the porous structure of softwood.

## Improving Wood Quality for Pulping and Biorefining

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## Abstract

Lignin is an aromatic heteropolymer that is deposited in cell walls of secondarily-thickened cells. It provides rigidity to cell walls, enabling plants to

withstand gravity, and makes water-conducting cells impermeable. For certain industrial applications, such as pulp and paper production or biorefining of lignocellulose into fermentable sugars, lignin is a limiting factor. Lignin has been known for decades to consist of p-coumaryl, coniferyl and sinapyl alcohol, but recent research has revealed a range of other monomers that can be incorporated into the polymer as well. This has allowed engineering lignin amount and composition, resulting in large increases in biomass processing efficiency. It is also possible to develop completely new lignin structures by expressing exotic genes, responsible for the biosynthesis of lignin monomer-like compounds, in lignifying cells. In several cases, the changes in lignin are associated with a biomass yield penalty, motivating the development of new strategies that avoid the yield penalty while maintaining the improved processing efficiency. A limited number of transgenic trees with altered lignin and improved biomass processing have been planted in experimental field trials, to investigate whether the improved properties observed in greenhouse conditions are maintained when trees are grown outdoors.

# My Last Hurrah: A Quick Retirement Review and Wrap-up of my Research Results in Wood Science and Sustainable Biomaterials

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## Abstract

After 40 years as a Professor of Wood Science/Sustainable Biomaterials/Microbiology, I retired in September 2023 without the opportunity to present our latest research findings at meetings because of Pandemic restrictions in the early 2020s. I will briefly summarize new findings from that period on: 1) Wood Decay, 2) Formaldehyde Release from Wood, 3) Marine Borer Wood Digestion, and 4) Grapevine Trunk Disease.

1) Further evidence of a non-enzymatic, chelator-mediated Fenton (CMF) mechanism as a major pathway responsible for wood degradation in the brown rot fungi is reviewed. The 3 discovery that the extracellular matrix, produced by most fungi, can potentially restrict extracellular enzyme movement from the fungal hyphae into wood cell walls, lends understanding to why brown rot fungi require a low-molecular weight CMF mechanism to digest wood. https://doi.org/10.1016/j.isci.2023.106851

2) Very low levels of formaldehyde gas are reported to cause cancer. Most formaldehyde research on wood products has focused on the adhesives/coatings used, but biogenic production of formaldehyde directly from lignocellulose is largely unexplored. We found that trace levels of iron within, or on the surface, of wood triggers lignin demethoxylation; a primary cause of low-level formaldehyde release from wood. https://doi.org/10.1039/D2GC02632E

3) The mechanism of wood digestion by marine shipworms is still poorly understood despite considerable in-depth research. Shipworms and their gill symbionts are known to produce cellulases (https://doi.org/10.3389/fmicb.2021.665001) but there is no mechanism yet discovered for lignin deconstruction to allow the shipworm's digestive enzymes access to the carbohydrate-rich components. Our research into this area is summarized with exciting new findings.

4) Research on fungal pathogens causing significant damage to vineyards found that the brown rot CMF mechanism is also present in some fungi that cause vine damage and woody necrosis in grapevines. This results in significant damage to vineyards worldwide and I will report on our discovery of this mechanism. https://doi.org/10.3389/fpls.2022.921961 https://doi.org/10.3390/jof9040498

# Wood Modification Based on In-situ Esterification of *Pinus Sylvestris* with Citric Acid and Sorbitol

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## Abstract

Wood intended for outdoor application has to be resistant to biological degradation. Traditionally, tropical wood species with intrinsically high durability or home-grown preservative-treated wood have been used for that purpose. However, the last years brought various restrictions regarding the import of tropical timber and the use of biocide-containing preservatives. Therefore, it became inevitable to find a biocide-free way of protecting native wood material against decay, for instance via wood modification. Within the last years, the most groundbreaking invention in that field has been wood modification with bio-delivered polycarboxylic acids and polyols. In particular, wood treatment with sorbitol and citric acid (SorCA) has been very promising.

One of the main objectives of my work was to transfer the SorCA modification process from the laboratory to pilot scale with the overarching goal of industrialization. Therefore, it was important to find a quality control method, which would rapidly and accurately determine the treatment level at the cross-section of treated boards. In the experimental part, solid wood was impregnated with aqueous solutions of sorbitol and citric acid at various molar ratios and concentrations and, subsequently, wood samples were dry-cured at elevated temperatures. Electromagnetic radiation-based methods were tested (X-ray density profiling, mid- and near-infrared spectroscopy) and their predictive power to assess the treatment level (weight-percent-gain, WPG) was determined. The ultimate goal was a ho-

mogeneous impregnation and treatment of wood with SorCA modification system, which is a major challenge for any type of impregnation modification. Some approaches to mitigate this issue were attempted and presented in this work.

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## Recent Research with Archaeological Wood: Identification and Analysis of Very Small or Particulate Material and Taxa with Anomalous Anatomical Structure

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## Abstract

I describe three examples of my recent research involving very small or fine-particulate specimens of archaeological wood, in which I availed novel techniques to discern wood presence and conduct taxonomic assignments. The examples include waterlogged material isolated from a sediment core retrieved from an extinct volcano in the Pribilof Islands; sedimentary charcoal from an ancient (Viking) inhabited cave in Iceland; and charcoal particles that served as constituents of the clay pastes in the manufacture of Native American ceramics. I also describe my current research on a large assemblage of carbonized wood assigned to the mangrove species *Avicennia germinans* (Acanthaceae) from a series of archaeological sites in Florida.

This tropical wood was the primary fuelwood utilized by the inhabitants of the sites spanning several millennia and is characterized by anomalous anatomical structure (successive cambia), thus atypical growth increments. My analyses of the charcoal assemblage emphasize original wood caliber and age at harvest, growth increment composition, functional anatomy, and evidence for deadwood versus live wood collection. The details evince time-transgressive forest management practices by Native Americans, hypothetically involving coppicing and woodlot rotations, which resulted in the long-term sustainability of fuelwood resources.

## Research and Development on Bamboo Properties and Bamboo Fiber-based Composites for Plastic Substitute

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## Abstract

The overuse and abandonment of plastic has damaged to the environment and human health. Therefore, reducing plastic pollution has become a global consensus. Many countries around the world including China have sufficient bamboo resources but have not been fully utilized still. In this report, firstly the characteristics and utilization advantages of bamboo and bamboo fiber were introduced and analyzed, and then the potential of bamboo fiber-based products for plastic substitution used in daily and industrial fields were explained. Furthermore, the bamboo fiber tableware and automotive interior components have been introduced emphatically, which involves in manufacturing, performance and application etc. Finally, developing trend and prospects of replacing partial plastic products with

bamboo-based composite material have been raised and summarized briefly.

## Transfer Learning for Predicting Wood Density of Different Tree Species: Calibration Transfer from Portable NIR Spectrometer to Hyperspectral Imaging

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### Abstract

Wood density is a crucial property indicator for construction material selection, quality assessment, and modification. Spectral analysis techniques and chemometric models offer potential solutions for the rapid and non-destructive assessment (NDA) of wood density. However, probe-contact spectroscopy has low efficiency in spectrum collection, and spectral models are highly specific to variations in instruments and samples. Traditional calibration transfer (CT) methods are diverse and struggle to adapt to domains with significant distributional differences. By simulating operations under natural light, this work aimed at exploring a deep transfer-learning (DTL) strategy, facilitating the transfer of wood density prediction models between different instruments (from portable near-infrared

(NIR) spectrometers to hyperspectral-imaging (HSI) imagers) and among tree species (two softwood and two hardwood species). A bidirectional gated recurrent unit plus attention layer (BiGRUattention) was employed as the basic topology for the deep network. The results indicated that the generalization ability and robustness of HSI model transferred by deep adversarial transfer-learning (DATL) strategy, including domain-adversarial-neural Network (DANN) and dynamic-adversarial- adaptation network (DAAN), surpassed traditional CT and DTL methods, achieving a level comparable to NIR-calibrated models. DAAN based on Wasserstein distance with gradient penalty (WgpDAAN) optimized model accuracy, convergence speed, and stability. The DATL model could be adapted to wood spectral data from different instruments and tree species, where WgpDAAN significantly reduced modeling costs and enhanced productivity, and could be extended to detecting and characterizing other wood properties.

**Keywords**: Wood density; Transfer learning; Near-infrared spectroscopy; Hyperspectral imaging; Calibration Transfer; Non-destructive Assessment

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