LIST OF SESSIONS

FORESTS & SOCIETY TOWARDS 2050

STOCKHOLM 2024
26th WORLD CONGRESS IUFRO
FORESTS & SOCIETY TOWARDS 2050

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Subplenary Theme 1
Strengthening forest resilience and adaptation to stress

Subplenary Theme 2
Towards a responsible forest bioeconomy

Subplenary Theme 3
Forest biodiversity and its ecosystem services

Subplenary Theme 4
Forests for sustainable societies

Subplenary Theme 5
Forests for the future

Technical Theme 1

Strengthening forest resilience and adaptation to stress

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Towards a responsible forest bioeconomy

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Close-to-nature silviculture for global change adaptation and mitigation

There are two contrasting trends in contemporary silviculture. One is towards ecologically-based practices and natural regeneration. Another is towards technologically-based practices and plantation forestry. The development towards ecologically-based silviculture is going on mainly in the established forest. The development towards technologically-based practices is going on mainly in afforestation or when regeneration or reforestation relies on the clearcutting system. These developments occur across the world, but approaches and progress vary substantially from continent to continent and from region to region.

Both lines of development claim to rely on adaptive silviculture: adaptive in terms of climate change as well as for biodiversity conservation, environmental protection and social responsibility. Is this too good to be true? Is close-to-nature always better than far-from-natural? Is close-to-nature even better than just-nature? What do we talk about when we refer to close-to-nature silviculture? Do we speak a common language, or do we need an interpreter?

The objective of this session is to discuss close-to-nature silviculture as a tool for global change adaptation and for climate change mitigation in forestry. Following a brief introduction to the concept of close-to-nature silviculture, speakers from different continents will showcase current trends and developments in forestry practice and research, contrasting ecologically-based and technologically-based management philosophies in natural as well as plantation forests.

Jens Peter Skovsgaard[1], Linda Nagel[2], Verónica Loewe Muñoz[3], Toshiaki Owari[4]

[1] Swedish University of Agricultural Sciences, Sweden

[2] Utah State University, USA

[3] Instituto Forestal-CENAMAD, Chile

[4] University of Tokyo, Japan

Forest health under climate change and air pollution

Forests are exposed to multiple types of environmental pollutions and climate changes from local to global scales, including O_3 pollution, elevated CO_2, climate warming, droughts, flooding, wild fires, and new contaminants of emerging concern. These stressors act individually and jointly to affect forest vegetation and its multi-dimensional interactions with co-occurring organisms, contributing to forest decline and threatening forest health. However, the concurrent effects of multiple stressors are poorly understood, future global change impacts on forests are highly uncertain, and adaptation of forests to global changes challenging. This session aims at providing a platform of knowledge from research seeking to address the effects of multiple global change factors, model and predict future impacts on forests, and promote adaptation of forests to global changes. Emphasis will be given to higher levels of biological organization, especially how global changes effects can modify communities and forest ecosystem health and how adaptation can be achieved. Through classic talks and flash-talk communication of recent findings, this session will promote the exchange of scientific information, stimulate discussion across diverse communities, and consider the translation of scientific information into practical applications and its transfer to societal education.

Lucy Amissah[1] , Evgenios Agathokleous[2], Zhaozhong Feng[3], Johanna Witzell[4], Elina Oksanen[5]

[1] CSIR-Forestry Research Institute of Ghana

[2] NUIST (male, China), Coordinator IUFRO RG 8.04.05 “Ground-level ozone

[3] NUIST (male, China), Deputy IUFRO Unit 8.04.00 “Impacts of air pollution and climate change on forest ecosystems

[4] Linnaeus University (female, Sweden), Deputy Coordinator 7.03.17 – Tree health in urban forests

[5] University of Eastern Finland (female, Finland), Coordinator 8.04.02 – Genetic, biochemical and physiological processes

Forests in a changing world – impacts on carbon and nutrient dynamics

Globally, forest ecosystems undergo pervasive shifts due to climate and land-use change, natural disturbances, and management activities. Particularly droughts, wildfires, insect outbreaks, or windthrow damage have intensified over the last decades with tremendous impacts on forest systems and ongoing climate change is predicted to continue this trend. Shifts in forest composition and structure, including tree mortality, can strongly affect soil-plant interactions with major implications for global biochemical cycles.

This session aims to bring together researchers investigating how changing forest ecosystems impact plant and soil carbon and nutrient dynamics. We aim to connect researchers from different disciplines, such as plant ecology, forest growth dynamics, soil sciences, and microbiology. Observational, experimental, and modelling studies on the impacts of natural forest disturbances (e.g. wildfire, pest and pathogens), management activities (e.g. harvest, tree species selection, thinning), and climate or land-use related forest changes (e.g. droughts, afforestation/deforestation) on carbon and nutrient cycles are welcome.

Special attention is given to planted forests and to identify which practices support or alter natural processes (e.g. growth rates) and to provide recommendations of best practices that could increase forest resilience to climate change.

Mathias Mayer[1] , Christophe Orazio[2], Nadine Rühr[3], Ellen Desie[4], Lars Vesterdal[5]

[1] Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Switzerland

[2] European Institute of Planted Forest (IEFC), France

[3] IMK-IFU, Karlsruhe Institute of Technology (KIT), Germany

[4] Department of Earth and Environmental Sciences, KU Leuven, Belgium

[5] Department of Geosciences and Natural Resource Management, University of Copenhagen, Denmark

Global water provision: Understanding the forest-soil-water nexus under forest management, climate change and increasing disturbances

In the face of global change with climate warming and growing water demands of a rising world population, clean water supply is becoming a global key priority for mankind. Forests influence water resources in multiple ways, and at multiple levels. Forests play a critical role in supplying clean water, as 75% of the world's accessible water comes from forests. Forests also play major roles in climate mitigation, protecting soil and infrastructure from erosion and landslides, mitigating various environmental risks (i.e., floods, drought, avalanches), and sustaining aquatic systems and functions. Because of these connections, managing the forest-soil-water nexus, directly and indirectly, contributes to all 17 Sustainable Development Goals (SDGs) established by the United Nations. Understanding the forest-soil-water nexus is essential for sustainably managing forests for water provision, soil protection, climate mitigation, and various other water-related ecosystem services and functions.

Globally, forests are undergoing significant changes due to human activities (forest harvesting, reforestation and forest landscape transformation, land use change, urbanization etc.) and forest disturbance (wildfire, insect infestation, drought etc.). These changes have been exacerbated by climate change impacts. Existing research on the forest-soil-water nexus highlights the large variations and even contradictions in hydrological responses to these changes, mainly due to the diversity of climate, soil and forest types, and local conditions. Despite over a century of research, more research and syntheses are needed to understand these variations and contradictions so that forest management practices and forest landscape restoration strategies for water provision can be scientifically sound and local-knowledge based. "Outstanding knowledge gaps on the forest-water nexus must urgently be tackled" is a key conclusion of the IUFRO 2017 global assessment report.

We are at a critical juncture, with forest disturbances expected to accelerate under future climate scenarios and the demand for water to increase with increasing global population. This session will showcase advances in understanding the interactions of forest, soil and water (quantity and quality), and their responses to forest management and increasing disturbance at multiple scales. It will demonstrate a critical need for an interdisciplinary and holistic approach to understanding this nexus as well as its drivers and responses. Emerging research gaps, priorities, and high-level management strategies will also be discussed and recommended.

Adam Wei[1, 2] , Shirong Liu[3, 4], Kevin Bishop[5, 6], Ge Sun[7, 8], Richard Harper[9, 10], Sara Casallas Ramirez[11], Andreas Bolte[12, 13], Mercy Derkyi[14, 15], Henrik Hartmann[16, 17], Brenda Baillie[18]

[1] University of British Columbia, Canada

[2] IUFRO Forest and Water Task Force Coordinator

[3] Vice President of IUFRO; Depute Coordinator of IUFRO Forest and Water Task Force

[4] Chinese Academy of Forestry, China

[5] IUFRO Forest and Water Task Force member

[6] Swedish University of Agricultural Sciences, Sweden

[7] IUFRO Division 8 (Officeholder)

[8] USDA Forest Services, USA

[9] Depute Coordinator of IUFRO Forest and Water Task Force

[10] Murdoch University, Australia

[11] Forest-Water Program Coordinator, Food and Agriculture Organization (FAO) of the United Nations

[12] Coordinator of the IUFRO Task Force of Transforming Forest Landscapes for Future Climates and Human Well-being

[13] Federal Research Institute for Rural Areas, Forestry and Fisheries, Germany

[14] University of Energy and Natural Resources, Ghana

[15] Deputy coordinator Division 9 on Forest Policy and Economics

[16] Coordinator of the IUFRO Task Force on Monitoring of Global Tree Mortality Patterns and Trends

[17] MPI for Biogeochemistry, Germany

[18] Northland Regional Council, New Zealand

Governance of a Bio-resource-based Bioeconomy in the Global South

To date, most of the bioeconomy research focuses on the Global North, particularly on Europe and North America, where techno-scientific capacities for bio-based innovations tend to be concentrated. Less attention is accorded to other world regions, where different approaches to the bioeconomy are emerging. Assuming that a bioeconomy transition can only take place as a global endeavor, concentrating on a few regions and neglecting others is problematic since understandings, aims, contexts, problems, and solutions may differ substantially between countries and regions. There is an urgency to fill this knowledge gap in order to get a comprehensive understanding of the prospects and challenges concerning the governance of a global bioeconomy.

This session focuses on those bioeconomies that aim to and/or are going beyond technological fixes by addressing their conceptualizations and implementations through governance schemes promoting the use of bio-resources resulting from the agricultural and forest sectors. It thus aims to bring together international scholars who will help advance transnational bioeconomy research in two ways:

1. first, by thinking about the bio-based bioeconomy from the perspective of the Global South; This may include national, sub-national, regional, and transregional cases in Asia, Africa, Latin America, and the Middle East.
2. and second, by shedding light on the social and political aspects of the bioeconomy and its underlying problems; this includes goal conflicts and the reliance on bio-based resources, which touches upon contested issues such as land use changes and unequal access to bio-resources, as well as bioeconomy's governance architecture such as institutional structures, actors and discourses.

Daniela Kleinschmit[1] , Alex Giurca[2], Rosa Lehmann[3], Fabricio Rodríguez[4]

[1] Chair for Forest and Environmental Policy, University of Freiburg

[2] European Forest Institute (EFI)

[3] Heidelberg Center of Ibero-American Studies (HCIAS), Heidelberg University

[4] Arnold Bergstraesser Institut (ABI)

Smart Forestry – Transforming Forestry and the Future Forest Workforce

Today the forest sector across the globe faces critical challenges. Demands on forest products and ecosystem services are increasing and diversifying with a rapidly growing global population. Climate change increases uncertainty, complexity, and risk in the forestry system. A declining and aging workforce population has eroded the socio-economic fabric of forest-dependent communities. Logging is a difficult and dangerous job with high fatality rates. Uncompetitive wages and the lack of stable careers often threaten many rural forestry communities. A traditional one-size-fits-all approach in forest practices causes operational inefficiency, resource waste, and large environmental footprints of management activities. Financing entrepreneurship in forestry has become more difficult with high capital risk and diminishing infrastructure.

As the digital and smart technologies have fundamentally altered the way we live and work, the new technologies are being investigated as potential solutions to overcome the challenges. Forestry-specific precision and automation technologies are being developed to improve operational efficiency, reduce resource waste, mitigate environmental impacts, and enhance worker's health and safety. Simulation and virtual reality technologies are being developed and used in forestry education and workforce training to attract young generation to forestry and build and equip a forestry workforce with futureproof skills and technologies.

This proposed session invites technical presentations on the applications, innovations, and pioneering developments of smart technologies in forest production systems, environmental protection, workers' health and safety, forest education, and workforce training. This session will provide a forum to showcase the current and future research and applications of innovative technology in forestry that simultaneously promotes forest sustainability and societal benefits for managing forests.

Woodam Chung[1] , Rene Zamora[2]

[1] Department of Forest Engineering, Resources and Management, Oregon State University, U.S.A.

[2] World Resources Institute

Sustainable Woodfuel Production. Is it really possible? Social, Economic and Environmental Dimensions

Bioenergy is among the key options for achieving climate goals and can bring major socio-economic benefits, as the second largest employer in the renewable energy sector. Universal energy access requires replacing traditional use of biomass with clean and efficient technologies. Traditional bioenergy is the primary cooking fuel for 2.4 billion people around the world and has been playing important roles in many developing countries, but with major concerns on its social, economic, and environmental impacts, including those on indoor air pollution leading to health problem, forest degradation affecting forest ecosystem services, and greenhouse gas emissions that associate with climate change.

Modern use of bioenergy, especially woodfuel, would play a key role in achieving net-zero emissions, as reflected in the roadmap set out for the global energy sector in the International Energy Agency, which stated that modern bioenergy use would need to increase by around 60 percent between 2020 and 2050 alongside a shiver away from the traditional use of biomass. In order to meet the SDF targets of sustainable energy for all by 2030 and net zero emissions by 2050, there is an urgent need to support the transition from traditional use to modern use of woodfuel in terms of cleanness, efficiency and sustainability of wok production and transformation. Possible interventions include consolidating policies to ensure that the costs of wood sourcing for energy purpose better reflect the economic cost of wood; providing adequate incentives for woodfuel plantation and restoration of degraded forests; and nurturing business-oriented enterprises in the development and provision of innovative bioenergy products and services.

Woodfuel production can be "greened" by improvements at the various steps of value chains, from the forest to the consumer markets (e.g. improved forest management, new technologies for charcoal and firewood production, green certification, better supply strategies to local, urban and exports markets). Moving into a sustainable woodfuel sector could also help reduce emissions and contribute to low-carbon growth strategies committed by governments. It also contributes to energy access, livelihood resilience and risk management in the context of humanitarian responses in displacement settings.

This session aims at presenting the current challenges faced by the woodfuel sector in responding to the demand of a growing market of fuelwood and charcoal in many countries of the developing world, and the options that governments and donors have to develop strategies and solutions to make the production, transformation, and commercialization of wood products sustainable and carbon-neutral.

Gerardo Segura Warnholtz[1] , Xia Zuzhang[1], Tuyeni Heita Mwampamba[2], Jolien Schure[3]

[1] FAO. Forestry Division (FDO)

[2] Universidad Nacional Autonoma de Mexico (UNAM)

[3] Center for International Forestry Research (CIFOR)

Unlocking the bioeconomy for nontimber forest products

The bioeconomy, a progressive economic model, is a relatively new concept that more and more countries are pursuing. It was envisioned to address mega challenges – climate change, biodiversity lose, poverty alleviation –- as a positive contribution to most UN Sustainable Development Goals. The initial vision for a bioeconomy was to move away from fossil fuels, promoting renewable natural resources through application of biotechnology to increase efficiency and use of wood products (Bugge et al. 2016).

Non-wood forest products were neglected by this narrow vision. Though silviculture and farming are by definition biotechnologies, their paramount contributions to human development depends on sustainable production and conservation of biodiversity. The creation of value in a 'bio-ecological vision' of a bioeconomy, based on bio-based products, processes and principles, e.g., circularity and no-waste, is more through integrated production systems and high-quality geographically branded, certified sustainably sourced products (Bugge et al. 2016) that support sustainable and equitable rural economic growth.

In 2019, at the World Forestry Congress in Curitiba, Brazil the IUFRO Board commissioned the Task Force "*Unlocking the bioeconomy and nontimber forest products*", a global network of more than 70 scientists from 25 countries, representing 4 IUFRO Divisions focused on improving knowledge and the understanding of contributions of NTFPs to bioeconomies at all levels.

This sub plenary session presents major insights of the Task Force around three themes: 1) Where are we; an assessment of approaches to integrating NTFPs into bioeconomic strategies. 2) How do we move forward; NTFP related activities that support transition pathways. 3) Tools and technologies to help in the transition; silviculture and forest management with appropriate technologies for sustainable sourcing of NTFPs. Presentations of global analytic frameworks to assess integration of NTFPs into bioeconomies are included. Implications, challenges, and research needs to encourage transition will be conveyed. Participants will have opportunities discuss and explore needs for a broader analysis of a 'forest-based bioeconomy.' The session will allow for the sharing of NTFP bioeconomy educational materials.

This session sets the stage and compliments the many other related sessions. It provides global perspectives that reflect findings presented in the sub plenary session focused on Latin American & Caribbean. Knowledge shared in sessions on forest inventory, silviculture for edible forest products, and innovative production systems relate directly to a major theme of the Task Force. And, the broader concepts of an integrated bioeconomy with timber and nontimber are explored in a related session on forest-based bioeconomy.

James Chamberlain[1, 2, 3] , Carsten Smith-Hall[1, 3, 4], Mariana Melnykovych[1, 5, 6], Sven Mutke[7], Vitor Afonso Hoeflich[8], Verónica Loewe-Muñoz[9], Mi Sun Park[10], Harald Vacik[11], Sen Wang[12], Davide Pettenella[13]

[1] IUFRO Task Force "Unlocking the Bioeconomy and Nontimber Forest Products

[2] USDA Forest Service

[3] IUFRO Research Group 5.11

[4] University of Copenhagen, Denmark

[5] Agricultural, Forest and Food Sciences, Bern University of Applied Sciences, Germany

[6] IUFRO Working Group 4.05.05

[7] Forest Research Centre INIA-CIFOR, Spain, Coordinator RG 1.08

[8] Federal University of Parana, Brazil, Coordinator WG 4.05.03; Deputy Coordinator WG 9.05.08

[9] Chilean Forestry Institute (INFOR), Chile, Deputy Coordinator WG 1.08.00 and 1.01.13

[10] Seoul National University, Republic of Korea, Coordinator WP9.03.04, Deputy Coordinator WP 9.01.07

[11] University of Natural Resources and Life Sciences – Institute of Silviculture, Austria, Deputy Coordinator 4.03.03

[12] Regional Director, Fisheries and Oceans, Government of Canada, Winnipeg, Canada, DC 9.04.00

[13] University of Padova, Italy, DC 4.05.02

Assisted migration for adapting forests to climate change

Forest trees have evolved at species and population levels to adapt to the local environment in which they grow. Such local adaptations lead to genetically differentiated populations, with traits that enable them to adapt to biotic and abiotic stress factors. As climate changes, forest tree populations are likely to respond in three possible ways: adapt, migrate or become locally extinct. Migration and adaptation are very slow processes that can not keep up with rapidly changing climate, resulting in maladapted forests with reduced capacity to provide multiple ecosystem services. Some human-facilitated realignment will therefore be required to match or realign the populations to the environment to which they are best adapted. Such facilitated movement is commonly referred to as assisted migration, assisted colonization, assisted relocation, or facilitated migration.

To investigate the feasibility and effectiveness of assisted migration in forest trees, researchers could re-purpose a large number of long-term provenance trails, established for decades to test growth of seed sources at different locations. These reciprocal transplant experiments can also be used to make inferences for growth response to assisted migration, and this body of research generally suggests that many tree populations already grow under sub-optimal conditions and facilitated movement of such populations may be desirable to ensure health and productivity of planted forests under climate change. First results from new, purposely designed assisted migarion trials also emerge now, for example from the large-scale Assisted Migration Adaptation Trial (AMAT), to guide reforestation policy of the government of British Columbia.

In recent years, assisted migration for adapting forests to climate change has become a key area of academic research and management-focused research by government agencies responsible for reforestation. Almost no jurisdiction in the world that has experienced climate impacts on their forests believes that status-quo management of their forest resources is a viable strategy in the medium or long-term. We therefore believe that sharing the latest scientific developments from transplant experiments, methodological approaches to develop assisted migration prescriptions, and experience of practical implementation, policy challenges, and other aspects of assisted migration will attract a large and diverse audience.

Debojyoti Chakraborty[1] , Silvio Schueler[1], Andreas Hamann[2]

[1] Austrian Research Centre for Forests BFW, Vienna Austria

[2] University of Alberta, Canada

Restoring forests and trees: Balancing goals, interests and trade-offs

As a response to continuing forest loss and forest degradation, the past decades have seen an unprecedented increase in acknowledgement of the urgent need to restore forest ecosystems along with political commitments towards this aim. Worldwide, multilateral organizations, national governments, non-governmental and civil society organizations and private sector actors have pledged and initiated restoration efforts that aim at restoring millions of hectares of deforested and degraded lands. These initiatives emphasize an array and often competing goals, like mitigating climate change, restoring biodiversity, producing biomass, and improving local livelihoods, and it is critical how the aspirational goals and commitments are translated to national level targets and further to local or project level objectives. While there are many potential synergies among the goals, and different restoration approaches offer some opportunities for simultaneously providing benefits towards various goals, important trade-offs among the different goals also exist and must be recognized and considered. Restoration means different things to different actors and their values, interests, resources, capacities and powers vary greatly. In this connection restoration governance at all scales is crucial. There is a growing recognition among scientists and technicians that greater attention must be devoted to the socioecological contexts where restoration is implemented and specially to issues of governance, power and politics which crucially shape restoration goals, policies and approaches and the related outcomes at different spatial and temporal scales. Restoration and tree planting have a long history, which also provides important experiences and lessons for current restoration efforts.

This panel discussion will stimulate critical discussion on forest and forest landscape restoration by discussing the evidence and experiences on crucial questions. How is restoration understood? Which logics drive restoration policies and practice? What are the related rationales, institutions, interests, ideas and actors? How and who decide restoration objectives and desired outcomes? Which restoration pathways dominate? Are different knowledge systems considered? How are the costs of and benefits from restoration distributed among different actors? What are the impacts of restoration on equity and justice? What are the main issues, challenges and trade-offs especially in locations where restoration is implemented?

The session is closely linked to IUFRO-WFSE project's latest book "Restoring forests and trees for sustainable development - Policies, practices, impacts and ways forward".

Glenn Galloway[1] , Georg Winkel[2], Pia Katila[3]

[1] University of Florida

[2] Wageningen University & Research

[3] Natural Resources Institute Finland, coordinator of IUFRO-WFSE

Building international initiatives to strengthen forest adaptation strategies in a changing climate

All over the world, scientists and citizens alike are observing how a changing climate is disrupting and endangering forest ecosystems. Reports of dieback and mortality are increasing in all types of forests and under all types of environments and in particular climates. Strategies for managing forest adaptation to climate change cannot effectively be designed within national or legislative boundaries. Functional processes in forest ecosystems are based on inherent ecological interactions, not laws and regulations, and climate change is a global phenomenon. Thus, development of forest adaptation strategies must be based on a sound scientific understanding of forest dynamics at relevant scales, spanning from local and regional impacts to continental and global trends in forest dynamics. To achieve such an understanding, exchange of data and information across national and legislative boundaries will provide a crucial knowledge base. In this context, large-scale international initiatives that are emerging in different regions of the world aim at facilitating data sharing and exchange as well as providing business models for reducing emissions. In this sub-plenary session, we will explore several international initiatives and examine how they drive forward our understanding of fundamental mechanisms that strengthen forest adaptation to a changing climate. For example, the IUFRO Task Force on "*monitoring of global tree mortality patterns and trends*", the LEAF coalition on "*Lowering Emissions by Accelerating Forest Finance*", the United Nations REDD+ initiative "*Reducing emissions from deforestation and forest degradation in developing countries*" and a more recent initiative by INRAE and CIRAD in France on "*Adaptation of forests and agroforests to climate change*".

The objectives of this subplenary are: 1) to present as exhaustive as possible an inventory of initiatives to strengthen forest adaption to climate change, 2) to give the opportunity to the coordinators and participants of these projects to get together and present and confront their visions, 3) for all interested participants, to learn about and discover how they can potentially contribute and 4) to reflect on how these international initiatives may complement and enrich each other. We even propose to go as far as thinking about how some of them could join forces, or even federate, as well as pointing out conflicting interests in an attempt to explore solutions. We will provide information on how to identify and join current and future large-scale experimental approaches on forest adaptation to climate change research.

Philippe Rozenberg[1] , Alexia Stokes[1], Hui Wang[2], Henrik Hartmann[3], Claire Depardieu[4], María Elena Fernández[5]

[1] ECODIV, INRAE, France

[2] Professor of Forest Ecology & Management, Ecology and Nature Conservation Institute, Chinese Academy of Forestry, IUFRO Deputy Coordinator 8.01.00 – Forest ecosystem functions, China

[3] Group leader Plant Allocation, MPI for Biogeochemistry, Germany, IUFRO Task Force on monitoring of global tree mortality patterns and trends, Germany

[4] Research associate, Université Laval and Natural Resources, Canada, Coordinator for the UniC International Student Network, Canada

[5] Scientific Researcher CONICET, Argentina, Editor of Forest Ecology and Management, Argentina

Forest Policy and Justifying Role of Science in Tropical Countries. A High-Level Policy Panel Dialogue

This is sub plenary session and might not fit for the technical session or merging with another session. A world of political push and pull in left and right directions have impacted our societies. In this fragmented world, how forest policy is shaped determines the way we can manage the forests for people. More than before, forest science can play a pivotal role in unifying the fragmented political world to call for equitable forest governance.

This high-level panel dialogue will encourage us - diverse stakeholders of the Global North and the Global South - to think beyond our comfort zone questioning our 'way of doing forest and people science' to enhance social equity and inclusive sustainability. A few fundamental questions that the round table dialogue will highlight are

- How are we doing science to influence forest policy (OR is forest policy influencing our research)?
- Who are we (or should be) addressing our science to influence forest policy?
- Why policy influence works (or not) - examples and illustrations from each speaker.

One of the important outcomes of this dialogue is to discuss the challenges that the political scenario causes and how forest science can help multi-stakeholders to implement forest and people policy into practice. We will highlight Indigenous peoples and local communities (men, women, youth, gender), and the role of community-managed forests, trees, and agroforestry in local-level governance.

IUFRO platform, I think, is ideal to amplify this topic and would provide a valuable way forward agenda for setting the tone toward and beyond Agenda 2030. Diverse key speakers as proposed below - gender and geographical balance from a range of institutes will do justice to this sub-plenary session.

Purabi Bose[1, 2]

[1] Coordinator, IUFRO Division 6 Social Aspects of Forests and Forestry

[2] Senior Lecturer in Forest Policy, Forest Science Faculty, Department SSFRC, Swedish University of Agricultural Sciences, Sweden

Socio-ecological conflicts in forest management: Risks of (not) adapting?

This session will focus on the role of risk analysis and appraisal in forest decision-making process. As expectations about future state of the risks and associate uncertainties define the future action plans, the potential conflicts emanating from the divergences in terms of expectations towards the forest, from various actors. In particular, society's expectations can sometimes be in conflict with forest expectations in terms of ecology or economy. Thus, public access to a forest can be facilitated (construction of access roads, recreational areas, etc.) to the detriment of the preservation of biodiversity. However, expectations can also converge. Thus, society is more and more inclined to use wood material and this is in line with the economic expectations that weigh on the forestry sector. The interests can thus be convergent or divergent between the various actors of the society, and that is why to approach this topic within the conference seems to us interesting. The risks associated with conflict situations can generate inertia and "non-action", which is undesirable in a context of climate change. Indeed, forests have a role to play in terms of mitigation and for this they must adapt. These conflicts could then generate "non-adaptation" or "bad adaptation", which would be harmful. This multi-disciplinary theme should lead to interesting and varied presentations.

The conference has the following specific objectives:

- Modelling of natural hazards characteristics, frequency and intensity
- Disturbances of biotic and abiotic agents in forests
- Presenting approaches and tools to deal with risk and uncertainty in forest
- Identifying potential obstacles and levers to forest adaptation
- Dealing with behavioral components of decision-making process
- Tradeoffs (or not) between adaptation and other objectives such as mitigation
- Acceptability of adaptation by the society at large
- Economic efficiency of adaptation measures

The session includes keynote speakers as well as presentations from other researchers.

The session is organized by muyltiple working groups;

1. Coordinator (Rasoul Yousefpour) of IUFRO 4.04.07 "Risk Analysis"
2. Deputy Coordinator (Marielle Brunette) of IUFRO 4.04.07 "Risk Analysis",
3. Coordinator Division 4 IB – IUFRO Board, Coordinator Division 4 IEB – IUFRO Enlarged Board, Coordinator Division 4 4.00.00 – Forest Assessment, Modelling and Management (Donald Hodges),
4. Coordinator 4.04.04 – Sustainable forest management scheduling (Jose Borges)

Rasoul Yousefpour[1] , Marielle Brunette[2], Donald Haodges[3], Jose Borges[4]

[1] Faculty of Environment and Natural Resources, University of Freiburg, Germany

[2] Bureau for Economic Theory and Application, INRAE, France

[3] Department of Forestry, Wildlife and Fisheries, University of Tennessee, USA

[4] School of Agriculture Forest Research Centre at University of Lisboa Portugal

How to incorporate indigenous and local knowledge in forest education, back to the roots

Approximately half of the world´s forest and farm landscapes are in the hands of Indigenous Peoples and Local Communities (IPLCs) (FAO, 2022), these lands are important to safeguard human prosperity. The Global Assessment of Forest Education 2022 highlighted the need to include more information about ecological, cultural, and social values, traditional knowledge, and rights of Indigenous Peoples and Local Communities (IPLCs) in forest programs. IPLC diverse values and culture frame forest management and engagement with traditional forest science. Consequently, it is time to revise forest programs and reflect on how future forest professionals and incoming forest students would be able to understand the diverse ways in which people related to the forest; so that the contributions of trees and forests to local people can be systematically shared, supporting informed decision and policy-making.

Thus, future forest professionals will have a clear understanding of IPLCs governance structures so they will develop strategies that account for IPLCs' challenges when harvesting timber and other forest products and services. Therefore, updating and expanding forest educational policies, curricula, and training systems are needed all over the world to better integrate the perspectives and needs of all forest-related groups of people.

This session seeks to engage in a dialogue with a diverse group of forest actors to identify opportunities to

- Include IPLC into the forest programs and consequently forest management plans
- Bring traditional knowledge to key forest actors
- Enhance understanding and appreciation of the roles and contributions of IPLCs to sustainable forest landscape management
- Increase the number of members of IPLCs in the forest education institutions, and forest management authorities from the landscape to national levels
- Impact forest sector jobs opportunities and career appeal for young people, especially for members of IPLCs.

This subplenary is designed to learn more about the challenges and opportunities to include cultural and social values, traditional knowledge, and rights of IPLCs in higher education forest programs.

Sandra Rodriguez[1] , Mika Rekola[2], Annie Biju[3]

[1] Universidad Autonoma de Chihuahua, México

[2] University of Helsinki, Finland

[3] Joint IUFRO-IFSA Task Force on Forest Education, IUFRO

In practice of a gender equal and inclusive forestry sector

Gender equality has remained a key concern in various forestry contexts and at different levels. In addition to issues obviously related to SDG5 i.e. legal requirement, social responsibilities and legitimacy, matters of innovation, competence, work environment, product development and markets has more recently also been brought to the forefront. Thus, the interplay between policy and its implementation underlines the interrelation between policy and practices related to gender, i.e. gender equality initiatives in the broad frame ofgovernance. Yet, work targeting gender equalityhas been shown to face specific challenges and obstacles because men have numerically, culturally and symbolically dominated the industry and its organisations. Furthermore, the present political context has brought about a change in the function and processes of policies in the shifting relations of the state, international actors, markets and civil society. This has also impacted the framing, the approaches, and proposed solutions to gender inequities. In many forest-related contexts, gender equality is viewed as instrumental for development of the sector, while the growing awareness has begun to translate and materialize into actions for change, both at individual organizational and sectorial level. In the latter cases, individual organizations are facing uncertainty about the process and its requirements for gender equality and also uncertainty about the will to increase the efficiency in actions and resources used. But overall, the limitations of individual organizations actions in terms of change have to be acknowledged- not at least from the point of view of attractiveness, recruitment and competence. The various social and institutional settings of regional and/or national forest sectors provide different possibilities and alternatives for organization of these joint and collective efforts. All actors involved constitute a crucial factor for the process towards gender equality and inclusiveness- both in terms of its legitimacy, efficiency and resources. Two of these national examples are the *Forest sector's gender equality council* in Sweden and the *Free to grow* initiative in Canada, both involving a large number of actors from the different forest sectors in the process. In this context, the influence of forest certification schemes (e.g. FSC) is also to be considered. Another set of initiatives are grass-root mobilizations or collective actions and self-organization in network or other forms of grass-root initiatives with various forms of identity basis, that can be exemplified by Women Owning Woodlands Network in Oregon (US), Forstfrauen in Austria, Rede Mulher Florestal in Brazil, and Women's Professional Networks (NYKS) in Sweden.

Gun Lidestav[1]

[1] Swedish University of Agricultural Sciences, Sweden

Integration of gender and diversity perspectives in knowledge production

The social practices, processes and relations of knowledge production both within and outside academia, or at the interface between the academy and 'community'/public, shape how science is conducted and how research is produced. Thus far, the integration of social and the natural sciences has been very limited. There appears to be a necessity to strengthen the exchange between different epistemological views and hermeneutical perspectives on the issues that are currently at stance to achieve knowledge on various topic. The same limited integration can often be seen in the separation between 'forests' and 'people' by forest scientists and policy makers. However, the shortcomings of these approaches and the need for a more social and pluralistic approach to forest sciences has been emphasized in recent years – not least for dealing with the effect of land degradation, deforestation and climate change. To address these pressing issues, attention to social dimensions is important both to understand the problem and to advance change. Most importantly, knowledge production in itself is socially and culturally embedded and situated, requiring researchers to pay attention to social relations and practices of both specific research topics and the research process itself. Various studies have shown e.g. how gendered norms, relations and perceptions shapes analysis and interpretations of phenomena and behaviours in nature, which highlights the importance of interdisciplinarity as the majority of research take place in the intersection between society and nature. A reflexive and critical approach to understanding the present state of knowledge, its foundations, conditions, and practices is therefore necessary in order to more effectively bring different knowledge systems together to address societal challenges. Engaging various forest science disciplines from multiple standpoints has the potential to enhance present knowledge and understandings, and to open up new areas where integration of knowledge is needed.

This session sets out to investigate knowledge production in forest science from different social perspectives. This will be done e.g. by exploring intersectional, such as gendered and racialised dimensions, alternative practices of knowledge production, as well as critical approaches to co-creation and modes of deliberation that (un)mask domination and inequalities.

Elias Andersson[1] , Kalpana Giri[2], Gillian Petrokofsky[3]

[1] Department of Forest Resource Managemnet, Swedish University of Agricualtural Sciences, Sweden

[2] World Resources Institute

[3] University of Oxford

Transforming and restoring forests for more resilient landscapes and societies – towards the IUFRO Stockholm declaration

Forest landscapes, dominated by forests with other embedded land covers and uses, provide multiple essential ecosystem services (ES). These include (i) provisioning services such as the provision of food, raw materials, fresh water and medicinal resources; (ii) regulating services such as carbon sequestration and storage for climate protection, regulation of the landscape water cycling and climate, moderation of extreme events and natural hazards, mitigating erosion, landslides, flooding and avalanches; (iii) cultural services for recreation, mental and physical health, tourism, and aesthetic, cultural and spiritual experiences, as well as (iv) supporting services for preserving biodiversity (Hassan et al. 2015). For rural populations, forest landscapes are often the basis for their livelihoods, local economy, and social identity. Forest landscapes are social–ecological systems shaped by multiple influences. However, they are under pressure with the loss and degradation of forest areas, reduced biodiversity, and conversion of forests to other land uses. Environmental and climate change are rapidly altering forest ecosystems' growth, survival, and regeneration conditions (IPBES, 2018). To prevent this continued loss of ecosystem services and biodiversity on a global scale, actions are needed that combine forest landscape preservation, restoration and adaptive management.

The important role of forest landscape restoration and management for all 17 Sustainable Development Goals (SGD) has already been highlighted (e.g., Mansourian 2018). Regional initiatives such as AFR100 in Africa and Initiative 20x20 in Latin America are promoting restoration from the ground up and scaling collaboration among countries in the global south. Both initiatives combined have pledge to restore more than 150 million hectares of degraded landscapes. These developments underpin the need for presentation and discussion of the science relating to the state, options and limitations of Forest Landscape Transformation and Restoration. This is a core task for the whole IUFRO community that involves its transdisciplinary networks worldwide.

This session will address this need, with a particular focus on challenges in the "global south" where IUFRO has engaged its network of developing country scientists to provide breakthrough contributions for potential solutions and implementation pathways. IUFRO's latest advances in R&D for FLT and FLR will be discussed and presented to inform the IUFRO Stockholm declaration on global forest transformation and restoration.

Andreas Bolte[1] , John Stanturf[2], Stephanie Mansourian[3], Mercy Derkyi[4], Palle Madsen[5], Michael Kleine[6]

[1] Thünen Institute of Forest Ecosystems, Eberswalde, Germany, TF 45 coordinator "Transforming Forest Landscapes for Future Climates and Human Well-Being", Deputy chair 1.01.00, Temporal and Boreal Silviculture

[2] Estonian University of Life Sciences, Tartu, Estonia, Email: drdirt48@gmail.com

[3] University of Geneva, Crassier, Switzerland, Email: smansourian@infomaniak.ch

[4] University of Energy and Natural Resources, Sunyani, Ghana, Deputy coordinator Division 9 on Forest Policy and Economics, Email: mercy.derkyi@uenr.edu.gh

[5] InnovaSilva, Vejle, Denmark, Email: palle@innovasilva.com

[6] International Union of Forest Research Organizations, Vienna, Austria, SPDC-Coordinator, IUFRO, Email: kleine@iufro.org

Biology, ecology and management of pest and pathogen invasions in forests: a global perspective

Invasive alien tree pests (including insects and pathogens) are increasingly introduced directly or indirectly by humans into places out of their natural range of distribution, where they can become established and spread and have a detrimental impact on local ecosystems. Given the increasing global demand for forest products that relies on healthy and productive forests, the need to limit the potential movement of pests, and to contain and control new pest incursions through improved biosecurity systems is one of the most pressing phytosanitary issues in the world today. Key to successful control and management of new invasions is their early detection and rapid on-the-ground response by relevant agencies, which can be severely challenged by lack of adequate resources, preparation, and technological tools. Yet, several technologies are now mature for development of need-driven, practical scale biosecurity toolkits. Increased knowledge of pest biology and ecology, and the intrinsic and extrinsic factors influencing their spread, is needed to make informed decisions about mitigation measures to reduce economic and ecological impacts. Capacity building activities delivered by nations with a more-developed biosecurity system are becoming increasingly valuable for early detection of invasives. This session will cover and welcome a broad range of topics related to biosecurity, invasion biology, international regulations that limit the spread of forest pests and the management of incursions of pests, including: rapid and portable molecular tools, eDNA methods for monitoring populations, smart trapping, AI recognition systems, sentinel plantings, phytosanitary programs and treatments, surveillance tools, biological control, and use of tree resistance breeding to avoid impacts. A global perspective will be brought by discussions of the regulatory context of international trade of forest products, the science that underpins this regulatory context, and by showcasing a variety of biological invasions of pests from around the world, including case studies of preparedness and pest incursion response.

Michelle Cleary[1] , Alberto Santini[2], Eckehard Brockerhoff[3], Chris Howard[4]

[1] Swedish University of Agricultural Sciences, Sweden

[2] National Research Council, Institute for Sustainable Plant Protection, Italy

[3] Swiss Federal Research Insitute WSL, Switzerland

[4] Department of Agriculture, Fisheries and Forestry, Australia

Carbon sinks in forest soils as controlled by fine-root dynamics

In forest ecosystems fine roots and their associated organisms are the primary sources of soil organic carbon (SOC). An important pathway of belowground organic carbon input is fine-root productivity and turnover, i.e. the growth and decay of fine roots over a certain time period, and their subsequent decomposition. To date the influences of various biotic (e.g., species composition and diversity, silvicultural interventions) and abiotic factors (e.g., soil type, temperature and moisture) on fine-root turnover and biomass have been studied. However, results are contradicting, and understanding the underlying mechanisms is of great importance to predict effects of climate change on fine-root dynamics and ultimately on SOC. As a concrete example, a timely question is whether tree diversity promotes belowground productivity thereby likely affecting SOC storage, or whether the reverse may be the case. Increasing C stocks in soils with higher root biomass lead to the conclusion that belowground niche complementarity could be a driving mechanism for higher root C input with higher tree diversity. However, root responses to mixing tree species may not be a universal phenomenon and can vary with species identity and the composition of functional groups which will subsequently influence the belowground C storage capacity and terrestrial C cycling. Thus, the direct impacts of tree diversity on fine-root dynamics and their feedback to SOC remain elusive and are a critical missing element for reliable soil C models. Likewise, the context-dependency of the influence of fine roots on SOC dynamics in forests is still poorly understood.

Consequently, it is crucial to assess under what conditions fine-root biomass, productivity and turnover are higher and build a mechanistic understanding to be able to better determine the potential of increasing C storage and how to manage forests to do so. Especially world system models lack consistent data about the belowground C storage ability, which make predictions about future mitigation potentials of forests difficult.

This session aims at giving a broad and worldwide overview of field observations on fine-root dynamics in forest ecosystems and plantations. We want to bring together experts to discuss knowledge gaps to foster a better understanding of the hidden half of forests and identify future research directions towards more adaptive forest management in regard to climate change.

Friderike Beyer[1] , Dai Saito[1], Janna Wambsganss[2], Andreas Bolte[3], Heljä-Sisko Helmisaari[4]

[1] Chair of Silviculture, Faculty of Environment and Natural Resources, University of Freiburg, Germany

[2] Research Institute for Forest Ecology and Forestry Rhineland-Palatinate, Germany

[3] Thünen Institute of Forest Ecosystems, Eberswalde, Germany

[4] Department of Forest Sciences, University of Helsinki, Finland

Challenges for silviculture to meet demands from carbon sequestration to biodiversity conservation to forest restoration

The role of forests to sequester carbon, provide biodiversity habitats, conserve and secure local communities with wood production are required more than ever. Global environmental and social issues complicate forest practices with controversial goals between intensive silviculture for wood production and carbon sequestration and providing ecosystem services. Carbon sequestration may favor fast growing species, whereas biodiversity conservation should consider slow growing old-growth species. Diverse regions have different environmental conditions which result in different disturbance regimes and forest strategies.

In all cases of forest management, silvicultural practices work as a critical tool to meet the management goals. Much of silvicultural practices that were originally developed for sound wood production, has been expanded its applications to meet diverse management goals, including forest restoration, carbon sequestration and the reduction of disturbance impacts. Although various activities to solve environmental problems utilize silvicultural techniques, detailed silvicultural techniques that were used for each purpose were not carefully investigated. In this session, we will look into the practices that have been used to meet management goals, and discuss the challenges to better meet the current and future goals.

The presentations would include silviculture to meet 1) carbon sequestration goals – comparison of techniques between carbon sequestration and wood production, 2) how silviculture can be applied to solve controversial matters between carbon sequestration and biodiversity, 3) silviculture for forest restoration, 4) wildland fire mitigation, 5) forest health, and 6) other ecosystem services.

Pil Sun Park[1] , Teresa de Jesus Fidalgo Fonseca[2], Jens Peter Skovsgaard[3], Khosro Saheb Talebi[4], Sandra Luque[5], Nathaniel M. Anderson[6]

[1] Seoul National University

[2] UNIVERSIDADE DE TRÁS-OS-MONTES E ALTO DOURO

[3] Coordinator of IUFRO Division 1

[4] Deputy coordinator of IUFRO Division

[5] Coordinator of IUFRO Division 8

[6] Deputy Coordinator of IUFRO 3.09.00

Climate Smart Forestry

Climate change impacts, adaptation and mitigation are undoubtedly at the forefront of issues at stake for global forests, and forest management. Climate-Smart Forestry (CSF) is designed as a prominent way to deal with this and is urgently needed to connect mitigation with adaption measures, enhancing the resilience of forest resources, adapting to disturbances, and meet the needs of a growing population. CSF carefully regards the local circumstances and adapts the measures accordingly. Many pilots are being executed and this session will present results from various regions in the world, show upscaling efforts and exchanges experiences based on CSF projects. In 2020, a European Network on Climate-Smart Forestry has started, with representatives from more than twelve European countries. The network gathers information, exchanges, stimulates capacity building to practice and stimulates research.

This session invites speakers from various parts of the world and from various disciplines to present their scientific and applied experiences, and discuss the results and what is needed to make steps forward.

also applied presentations are very welcome: e.g. investors in reforestation or carbon market projects are invited.

Gert-Jan Nabuurs[1] , Mariana Hassegawa[2], Bas Lerink[1], Daiga Zute[3], hans Verkerk[2]

[1] Wageningen University and Research

[2] European Forest Innstitute

[3] Latvian State Forest Research Institute Silava

Climate-smart pine forest management

The global change crisis is happening in front of our eyes. Climate-driven changes affect strongly tree growth, survival and disturbance dynamics in pine forests, similar to other forest ecosystems. The realised positive effects of climate change, such as higher growth rates and extended vegetation periods in boreal forests, are totally overshadowed even there by associated negative phenomena: warming, changing precipitation, an altered pattern of extreme weather events, forest fires and insects herbivores outbreaks. In temperate, Mediterranean and subtropical pine forest ecosystems, even climate and pest-prone decline events are reported, and major shifts in species composition of forests and woodlands are expected.

Many of these adverse consequences of climate change can be avoided, mitigated or at least delayed by implementation of adaptive forest management. Pine and mixed pine-broadleaves forests have a significant potential to become a vital part of these efforts. On the other hand, the role of pines for plantation forestry is paramount worldwide, providing essential ecosystems services such as timber, biomass and NWFPs provisioning for a bio-based economy.

This session intends to address the issue of forest management adaptation to climate changes, with the focus on pine forests. Both adaptation and mitigation efforts are of interest. The most important questions are: how to incorporate mitigation of the negative impacts of climate change into forest management and how to combine it with other ecological, social and economic goals? In this session we would welcome contributions that (i) implement adaptive concepts into forest management (ii) change stand structures and tree species composition in ways that make the resulting forest better adapted to the climate and maintain/increase genetic diversity (iii) use natural forest dynamics for optimizing stand development (iv) predicts, quantify and explore impacts of climate change on pine forests.

The objectives of the technical session are (i) to create space for presentation of current results of scientific work in the field of forest management and climate change adaptation, (ii) facilitate information and knowledge exchange and (iii) finally encourage discussions and collaborations between researchers from different disciplines.

Mikolaj Lula[1] , Emma Holmström[1], Teresa F. Fonseca[2], Santiago C. González-Martínez[3], Miren del Río[4], Sven Mutke[5]

[1] Southern Swedish Forest Research Centre

[2] Coordinator WP1.01.10 Ecology and Silviculture of Pine

[3] Coordinator Division 2 Physiology and Genetics

[4] Deputy RG1.09.00 Ecology and silviculture of mixed forests

[5] Coordinator RG1.08.00 Silviculture for edible NWFP

Coastal Blue Forests: Global Significance, Ecology, Management and Conservation

Coastal Blue Forests exist at the interface of terrestrial and marine ecosystems, extending from the boreal zone to the tropics. Despite their small proportion to the global forest resource, the tidal freshwater forested wetlands and mangroves that comprise Blue Forests are globally recognized for providing highly valued ecosystem services integral to local livelihoods and having ecosystem carbon densities that exceed most terrestrial forests. Nevertheless, these ecosystems are threatened from climate change related sea level rise, deforestation, and conversion to other land uses throughout their range. A number of calls to action to explore the best options and measures to reverse the trend are made, but still substantial gaps in knowledge on their fate exists. The objective of this session is to synthesize the current state of knowledge regarding Coastal Blue Forest ecology, silviculture, management, monitoring, and potential as carbon sinks. We are proposing an oral session to convey the importance of these forests, synthesize the science underpinning management and monitoring efforts, characterize the diverse forest systems comprising Coastal Blue Forests, and highlight the intricacies associated with sustainable community-based management, restoration and conservation.

The proposed session will engage speakers and a plenary discussion to address: (a) definition and characterization of the resource (b) inventory, assessment, and monitoring (c) ecology, (d) silviculture & restoration potential, and (e) community-based management. We intend to invite a diverse panel of recognized experts from Asia, Africa, the Americas and Europe, representing the global extent of the resource, cultural diversity, and institutional perspectives. We would work with the speakers to craft a coherent program that incorporates the principal tenants of the session.

The session would open with a concise perspective on the general characteristics and extent of Blue Forests globally. Subsequent speakers would highlight inventory, and assessment with a focus on objective and synoptic inventory strategies, and synthesize advancements in the application of remote sensing and other tools for resource assessment and monitoring. The ecology of Coastal Blue Forests will be appraised through analysis of the differences in freshwater and marine environments. The session will include presentation on silvicultural systems for management and restoration of tidal freshwater forests and mangroves. Management, including restoration, of blue forests are inextricably linked to local communities; speakers will analyze the complexities of communities and governance systems in development of sustainable management approaches.

Carl Trettin[1] , Célia Macamo[2], Randall Kolka[1]

[1] Forest Service, U.S. Dept. Agriculture, United States of America

[2] Dept. Biological Sciences, Universidade Eduardo Mondlane, Mozambique

Collaborating for boreal forests futures

Boreal forests, the second most extensive terrestrial biome on earth, are experiencing environmental changes at rates that are unprecedented and higher than global averages. Home to unique landscapes and natural diversity, they provide crucial ecosystem services for the livelihoods of millions of people. At the same time, they can store as much carbon per hectare as tropical forests and they deliver much of the world's harvested wood products including timber, pulp and paper and biomass. However, the cumulative impacts of current environmental, social, economic, and technical changes on the boreal domain are highly uncertain. Climate change, expressed in temperature and precipitation changes, has far-ranging consequences such as the thawing of permafrost and devastating mega fires– among other threats. The resulting huge releases of greenhouse gases will further accelerate climate change.

This side event will be hosted by the International Boreal Forest Research Association (IBFRA) together with the International Institute for Applied Systems Analysis (IIASA) and Natural Resources Finland (LUKE). It will present the current scientific understanding of the vulnerability and resilience of the boreal biome to climate change. Particular emphasis will be placed on forest disturbances, forest management, and the potential for nature-based climate solutions in the boreal forests. This IBFRA side event at the IUFRO World Congress will also facilitate inter-disciplinary discussions between scientists from boreal countries, to increase understanding of the important role of boreal forest ecosystems in the global environment. The boreal forest contribution to global land-based sinks is essential for humanity to achieve net zero emissions in this century yet these ecosystems are at high risk from climate change impacts. The event will aim to promote and disseminate research results to ensure sustainable development and preservation of boreal forest ecosystems.

Florian Kraxner[1] , Raisa Mäkipää[2]

[1] International Institute for Applied Systems Analysis (IIASA)

[2] Natural Resources Institute Finland (LUKE)

Complex forests: Understanding and management of multiple species, structures and ecosystem services.

Forestry faces important challenges in the decades ahead. The quick global change affecting the climate system, economy and biodiversity has put forests in the front line of mitigation and adaptation policies across the world with different approaches. In temperate regions forest researchers and practitioners have already understood that more structurally and compositional diverse forest stands are essential to meet climate and bioeconomy targets.

This session will present current knowledge on complex forest structures research and practice. It will cover silvicultural and ecological aspects of multiple species and multi-aged stands dynamics as well as the consequences of increasing complexity for forest functioning, ecosystem services provision and biodiversity conservation. The session will also deal with measuring and modelling challenges that foresters and researchers are currently confronting. A final discussion among moderators, presenters and public will summarize the future of complex forest structures within the forestry discipline and their benefits for the bioeconomy.

Presentations for oral contributions and posters are welcome on the following topics: (i) Multiple species silviculture; (ii) Multi-aged structure silviculture; (iii) Functions, services and biodiversity and (iv) Measuring and Modelling the forest complexity.

The session is organized by the following IUFRO research groups RG1.09 Ecology and silviculture of mixed forests, RG1.05.00 - Uneven-aged silviculture; and units 1.01.06 - Ecology and silviculture of oak; 1.01.07 - Ecology and silviculture of beech; 1.01.09 - Ecology and silviculture of fir; 4.01.02 - Growth models for tree and stand simulation; 8.01.01 – Old growth forests and forest reserves.

Andrés Bravo-Oviedo[1] , Linda Nagel[2], Gary Kerr[3], Magnus Löf[4], William Keeton[5], Miren del Rio[6], Andrej Boncina[7], Felipe Bravo[8], Alfredo di Filippo[9], Mark J. Ducey[10], Hans Pretzsch[11]

[1] Department of Biogeography and Global Change, National Museum of Natural Sciences (MNCN-CSIC), Spain

[2] S.J. & Jessie E. Quinney College of Natural Resources, Utah State University, USA

[3] Forest Research, UK

[4] Swedish University of Agricultural Sciences, Southern Swedish Forest Research Centre, Sweden

[5] Rubenstein School of Environment and Natural Resources, University of Vermont, Burlington, Vermont, USA

[6] Forest Rearch Center, National Institute of Agricultural and Food Research, ICIFOR-CSIC, Spain

[7] Department of Forestry and Renewable Forest Resources, University of Ljubljana, Slovenia

[8] Sustainable Forest Management Research Institute, University of Valladolid, Spain

[9] University of Tuscia, IT

[10] Natural Resources and the Environment, University of New Hampshire, USA

[11] Technical University of Munich, Germany

Dendroecology for Evidence-based solutions and Resilient Forest landscapes

Climate change has become one of the biggest threats to nature and humanity. We are witnessing humanitarian crisis due to extreme weather events such as floods, droughts and increased frequency and intensity of dry spells in many countries. Forests play important roles in climate-change adaptation and mitigation while supporting biodiversity and securing ecosystem services. Restoring forests and forest landscapes is getting momentum as an important step in regaining the health and functionality of these ecosystems. On the other hand, it is becoming increasingly evident that patterns of growth, water use efficiency, and survivorship of tree species are sensitive to climate variations, and that stress induced mortality is prevalent, changing the complexion of forest landscapes. Assessment of vegetation vulnerability, climate change resilience and human adaptation options requires understanding tree species diversity in the current vegetation, genetic and phenotypic growth strategies as well as temporal and spatial response to fluctuating temperature and water availability. Unfortunately, science-based knowledge on tree selection and management is barely available, especially for most native tropical tree species.

Tree rings and stable isotopes in tree rings are key terrestrial archives providing insight into past climate and environmental variability at annual resolution, and from local to global scales. Tree ring proxies are also important as indicators of plant physiological responses to changing climatic conditions and disturbance regimes. These records can be used for understanding long-term hydrological and ecological processes that are needed for developing appropriate management actions and policy decisions benefitting peoples' livelihoods, health and the environment. We invite researchers to present their work related to dendroecology (tree-ring width, stable isotopes, dendrochemistry and quantitative wood anatomical analysis) and other physiological measurements. We encourage submissions linking different proxy records (such as remote sensing, modeling and ecophysiological measurements). Applications to land restoration, monitoring forest health, forest ecology, hydrology and ecosystem modeling at different temporal and spatial scales are particularly welcome. In this session, we will also discuss on the need to advance dendrochronology research, especially in the tropics where large-scale tree-ring based data is lacking compared to other regions.

Aster Gebrekirstos[1] , Achim Braeuning[2]

[1] CIFOR-ICRAF, Nairobi, Kenya

[2] Friedrich-Alexander-University (FAU) Erlangen-Nuremberg, Germany

Enhancing forest resilience for water-related ecosystem services in a changing environment

Forests as "natural reservoirs and filters" can store, release and purify water through various ecohydrological processes. Water-related ecosystem services provided by forests including water flow regulation, water supply and climate regulation, are critically important for human well-being. They are also fundamental for generating other ecosystem services such as carbon-sequestration and biodiversity-protection. Thus, restoring and managing water-related ecosystem services of forests is integral to achieving both the Paris Agreement and several SDGs and has raised great concerns among scientists and the public.

Unfortunately, forest ecosystems have undergone dramatic changes driven by human activities (deforestation e.g., logging, agricultural expansion, and reforestation or afforestation) and natural disturbances (e.g., wildfire, insect infestation). We are at a critical juncture. These forest disturbances are expected to accelerate with future climate change and the water demand will increase with increasing global population and improved livelihoods.

The persistence and functionality of these ecosystems are highly dependent on their resilience, namely the ability to withstand and recover from environmental perturbations (e.g., forest disturbances and climate change). Low-resilience ecosystems are more sensitive to anomalies in external drivers and potentially more exposed to abrupt and possibly irreversible shifts. This is particularly critical given the growing intensification of forest disturbance regimes that can impact the provision of water-related ecosystem services. In fact, satellite-based vegetation indices have already indicated a significant decline in the resilience of tropical, arid and temperate forests, possibly due to increasing water-limitations and climate variability. Obviously, forest management strategies for sustaining and restoring water-related ecosystem services rely on enhanced forest resilience in the context of ongoing environmental changes. However, little is known about the interactive mechanisms underlying forest resilience and hydrological response to global environmental changes due to the lack of long-term data and sound methodology available for multiple temporal and spatial scales, the complexities and variations of ecohydrological processes and their interactions with forests across biomes, variations in the forcing signals, and the presence of stochastic noise. This greatly impedes us from developing sound forest management plans to ensure water-related ecosystem services in a new paradigm of climate change mitigation and adaptation.

The session will focus on 1) how we improve forest resilience for water provision and other ecosystem services across global biomes in the context of climate change 2) determination of emerging research gaps and priorities; and 3) discussing and recommending cross-region and cross-continent governance for forest management for water-related ecosystem services in a broader geographic context.

Shirong Liu[1] , Adam Wei[2], Richard Harper[3], Henrik Hartmann[4], Ge Sun[5], Andreas Bolte[6], Christophe Orazio[7]

[1] Ecology and Nature Conservation Institute, Chinese Academy of Forestry, China

[2] University of British Columbia (Okanagan), Canada

[3] Murdoch University, Australia

[4] Max-Planck Institute for Biogeochemistry, Germany

[5] IUFRO Division 8 (Officeholder); USDA Forest Services, USA

[6] Coordinator of IUFRO Task Force "Transforming Forest Landscapes for Future Climates and Human Well-Being", Institute of Forest Ecosystems, Germany

[7] Coordinator of IUFRO Task Force "Resilient Planted Forests Serving Society & Bioeconomy", European Institute for cultivated forest Headquarters, France

Forest Fires in Mountain Regions

Climate change is undeniably responsible for the increase in climate-related disasters including wind storms, flooding, drought, and forest fire - to name a few. These disasters translate in billions of losses in economic turns and ten thousands of fatalities.

Climate disasters are often the result of compound events or cascading events - a combination of multiple climate-related hazards - that contribute to socio-ecological risks.

Forests provide essential ecosystem services that support human well-being and play a critical role in the mitigation of climate change, but their health and stability are also threatened by climate change. Therefore, hazard-resilient and sustainable forest management is key for managing climate-related risks.

In many global mountain regions forests are a key element for protecting people and assets against natural hazards. However, to be effective as an ecosystem-based solution for disaster risk reduction forests need to be resilient to climate change requiring action rather than reaction plans.

In this side event, we will concentrate on forest fires in global mountain regions and related state of the art research. Forest fires in mountain regions tend to have substantially different behavior and fire spreading patterns than forest fires in plane lands or large valleys. Fire speed is usually faster and fire fighting in clearly more difficult and also highly dangerous. Compound effects, or cascading effects are often the case when forest fires burn protective forests followed by an increase risk of rock fall and avalanches. Biodiversity is threatened. In this session we will discuss global forest hotspots in mountain regions, fire risk-resilient and biodiversity-friendly mountain forest management, and put special emphasis on relevant compound events with high risk of damage to people and society as well as climate.

Florian Kraxner[1] , Frederic Berger[2], Andrey Krasovskiy[1], Daphna Payne[3]

[1] International Institute for Applied Systems Analysis (IIASA), Austria

[2] National Research Institute for Agriculture, Food and the Environment (INRAE), France

[3] University of Bern

Forest genetics tools to improve forest resilience to climate change and forest health

Trees are under increasing threat from pathogens and pests that can potentially cause a reduction in growth and wood quality, increasing levels of tree mortality, and functional extinction of tree species and disruption of associated ecosystems. The effects of climate change are likely to increase the impacts of these biotic agents and lead to drastic changes in the dynamics of forest ecosystems. Genetics is a basic building block for organisms and species to evolve and help mitigate impacts of damaging biotic and abiotic agents and can be especially valuable in long-lived tree species. The use of forest genetic knowledge and tree breeding is a valuable tool in helping to ensure the forests of the future are healthy and resilient. The presentations in this proposed technical session will examine successful breeding programs for both commercial tree species and keystone tree species valued for a myriad of ecosystem services. Much of the current afforestation, reforestation or restoration efforts use local seed sources, but under climate change the adaptability of these populations may no longer be optimal; therefore, assisted migration is a tool widely being debated to replace or supplement local populations and help establish forests that will have the best chance of being healthy and resilient into the future. Success will require broad inter-disciplinary inputs from forest genetics, tree breeding, silviculture and forest health specialists at all stages of development and implementation. The technical session will address what is needed for success in both breeding and assisted migration, providing examples of successful applied programs and efforts that are underway. The current understanding of the genetics of the host-pathogen interaction will also be included. Understanding the interactions between hosts and pathogens may provide enhanced ways of increasing resistance to pathogens, such as targets for genetic engineering techniques. The topics addressed are broad but are all focussed on preventing forest trees from damage caused by pathogens. We will particularly encourage the participation of early career scientists and graduate students and invite posters to be presented.

Caterina Villari[1] , Rosario Garcia Gill[2], Tod Ramsfield[3, 4], Santiago Gonzalez-Martinez[5, 6], Jens Peter Skovsgaard[7, 8]

[1] University of Georgia

[2] Swedish University of Agricultural Sciences

[3] Natural Resources Canada, Canadian Forest Service, 5320 122 St NW, Edmonton, AB, T6H 3S5, Canada

[4] Coordinator of Division 7, Forest Health

[5] INRAE – National Research Institute for Agriculture, Food and Environment. 69 route d'Arcachon, 33610 Cestas, France

[6] Coordinator of Division 2, Physiology and Genetics.

[7] Swedish University of Agricultural Sciences, Alnarp, Sweden

[8] Coordinator of IUFRO Division 1

Forest management for climate change mitigation

The emissions of most greenhouse gases (GHG), including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), cause global climate change, becoming the world's most serious environmental problem. Forestry environment is one of the most important terrestrial ecosystems in regulating of GHG emission and carbon sequestration. Meanwhile, afforestation and forest management practices are needed to mitigate the change. Forest management using scientific ways can increase the carbon storage and sink of forest ecosystem, while that using non-scientific or excessive ways decreases the capacity of forest carbon sink, which could even be changed into carbon source. The forest managements in this session include but not limit to mountain closure for forest growth, near-natural management, ecosystem management, multi-functional management, and forest stand transformation. The interested subjects in the session focus on how those activities of forest management affect both the composition of carbon storage and the capacity of carbon sink of forest ecosystem? For example, how to affect the greenhouse gas emission of forest soil; how to affect the capacity of forest biomass. In addition, other interested subjects include the forest managements that can play the important role of forest carbon sink. Therefore, the objectives of this session are to present the latest studies on soil, vegetation and ecosystems in forestry land under the stress of climate change. This session will help forestry researchers, forestry officials and policy makers understand the increasing importance of forest ecosystem under global climate change, presenting a new glance at forest. The session will be organized by Zhejiang Agriculture and Forestry University, Nanjing Normal University, Chinese academy of forestry. The format will be technical session. It is expected to have 80 peoples and time range for 2 hours.

Yixiang Wang[1] , Zhibin Sun[2], Xianzhao Liu[3], Manuel Esteban Lucas Borja[4], Frank Berninger[5]

[1] Zhejiang Agriculture & Forestry University

[2] Nanjing Normal University, Nanjing, China

[3] Chinese Academy of Forestry, Beijing China

[4] Castilla La Mancha University, Spain

[5] University of Eastern Finland, Finland

Forest radioactive contamination: long-term dynamics and impact on ecosystem and society

Forests are the major ecosystem in both the area of land contaminated by the Chernobyl accident and those areas contaminated by the Fukushima accident. Nuclear accidents rarely occur, but when they do, they significantly affect forests and society. The number of nuclear power plants is increasing and, unfortunately, the Ukraine crisis showed us another type of risk of a possible nuclear disaster. The Chernobyl accident happened in 1986, and more than 35 years have passed. The Fukushima accident happened in 2011 and more than 10 years have passed. In both affected areas, radioactivity is still there and continues to affect society physically and through psychological stress. Radioactive particles circulate in forest ecosystems as material cycles and are taken in all components (including trees, soil, water, and wildlife), and these contaminations have been influencing societies, both physically and psychologically.

The session is designed to exchange knowledge from long-term studies in Chernobyl and Fukushima about the dynamics of radioactive materials and radiation in forests, for all forest components (tree, soil, water, mushroom, wildlife, etc.). Furthermore, the feature of this session is that the focus is beyond the dynamism and more on the indirect impact on forest ecosystems and society. Abandoned forests change forest biology and landscapes, including society and wildlife. Forest fires are also a potential issue. Social studies include the impact of forest contamination on people's lives and the forest industry, and also communication (education) with local residents. These dual focusses are unique in this session, but the approaches are inevitable in various problems we face in forest oversight.

The lessons learned in forests affected by previous disasters should be shared, deepened, and spread worldwide to help remediate affected forests for future generations; these lessons are essential for handling future nuclear accidents. IUFRO, the interdisciplinary organization, is the best place to pursue this mission.

Shoji Hashimoto[1, 2] , James Beasley[3], Gabriele Voigt[4], Mike Wood[5]

[1] Department of Forest Soils, Forestry and Forest Products Research Institute, Japan

[2] Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan

[3] Warnell School of Forestry and Natural Resources, University of Georgia, USA

[4] r.e.m GbR Consulting, Germany

[5] School of Science, Engineering & Environment, University of Salford, UK

Impacts of Global Change on Protective Forests in Mountain Areas

Forests provide indispensable protective services for Ecosystem-based Disaster Risk Reduction (Eco-DRR) in mountain areas. Thanks to this Forest-based Solution (FbS), costs of engineered technical protection measures can be reduced or even avoided. Numerous studies have proven the high effectiveness of forests in mitigating negative impacts of alpine natural hazards such as landslides, snow avalanches, rockfall, floods and debris flows. However, open questions remain on the long-term and sustainable provision of protective services, which are increasingly affected by global change.

Natural forest dynamics and disturbances, often accelerated by climate change, can result in temporary or irreversible changes to the forest cover. Rising temperatures and more frequent and severe drought periods may also lead to shifts in tree species composition. Socio-economic changes drive the expansion of settlements, transportation infrastructure and tourism activities but also land-use changes and the abandonment of mountain areas. These global change-related developments will influence the supply and alter the demand for protective services provided by forests. Furthermore, the associated uncertainties impose great challenges for the quantification and sustainable management of this key ecosystem service in mountain areas.

This session aims at highlighting recent advances in research to improve our understanding of the effects from the various implications global change has on protective forests. We therefore invite contributions that explicitly address impacts of global change on protective services of mountain forests, contributing to our understanding of how rising temperatures, increasing forest disturbance frequencies and intensities, and socio-economic changes affect the ecosystem service "protection against alpine natural hazards".

We aim for submissions from a variety of perspectives, e.g.:

- Studies on the interactions between forests and natural hazards as well as the underlying processes with respect to global change.
- Research on methods to include these interactions into process- or data-based hazard, risk, ecosystem service or other models and simulation tools operating at different spatial and temporal scales.
- Local case studies and regional to trans-national analyses quantifying and predicting the evolution of protective functions and effects of forests against alpine natural hazards under global change.
- Contributions presenting new and innovative methods or tools for decision support and the economic valuation of global change impacts on protective forests.
- Research on the vulnerability of mountain areas to global change and how it affects the utilization of FbS for Eco-DRR, in particular where resources are scarce, which are often areas underrepresented in research.

Michaela Teich[1] , Christine Moos[2], Alessandra Bottero[3, 4], Ana Stritih[5]

[1] Austrian Research Centre for Forests (BFW)

[2] Bern University of Applied Sciences (BFH)

[3] WSL Institute for Snow and Avalanche Research SLF

[4] Climate Change, Extremes and Natural Hazards in Alpine Regions Research Centre (CERC)

[5] Technical University of Munich (TUM)

Implementing fire-resilient landscapes

Fire-resilient landscapes are understood as territorial-scale socio-ecologic systems capable of addressing wildfire processes and impacts. They encompass proactive actions targeting wildfire risk phases (e.g., preparedness and prevention, response and emergency management, and post-event restoration) to achieve ecological and socially acceptable impacts. They encompass further ecological, societal and economic dimensions to forest management and its intersection with other sectors within the territory.

This session will revolve around new methods and tools targeting fire resilient territories. These include i) forest management options (e.g. fuel reduction in critical zones, restoration strategies, integrated fire management), ii) formal and social norms of its people (locals and visitors/users), iii) economic mechanisms affecting land and asset managers (e.g. foresters, WUI homeowners, shepherds) and iv) advanced decision support technologies (e.g, AI, DSS). How to achieve and maintain forest resilient structures and uses? How to make viable and affordable this society-forest-risk relation? How are the provision and demand for other ecosystem services addressed? (e.g. water-biodiversity-wildfire nexus).

In the ecology and landscape management dimension, discussions will tackle fire ecology, wildfire scenarios, forest and landscape management for fire risk reduction, adaptive management, ecosystem services integration and trade-off analysis in forest planning, wildland urban interface design, post-fire restoration. It will also tackle cross-links with nature conservation and land-use planning, with a special focus on climate change scenarios.

The discussion of social and legal barriers of the use of fire will be framed by recent challenges to address extreme wildfire events and to create fire resilient landscapes. Three different uses of fire will be discussed: traditional, prescribed and managed fires ('let it burn' or 'resource objectives wildfires'). Issues regarding risk culture, equity of vulnerable groups, collaborative and systemic risk governance to maintain resilient landscapes will be approached from both sides: stakeholders' engagement and institutional management.

The economic dimension analyses how to assign efficiently the scarce resources while simultaneously maintain a desirable level of ecosystem services pre- and post-fire and reduce the likelihood of future losses. This session includes discussion of economic variables shaping fire resilience, as well as of the design of economic instruments for facilitating the viability of the resilient landscapes.

The technological component will focus on recent advances on the development and application of artificial intelligence, namely machine learning and decision support systems to fire management. This does not preclude from relevant progresses in sensor-based systems to better detect i.a. ignitions, smoke, smoke components, humidity pre- and post-fire, fuel descriptive variables.

Elena Górriz-Mifsud[1] , Christophe Orazio[2], José G. Borges[3], Rasoul Yousefpour[4], Elena Feo[5], Marius Hauglin[6]

[1] Bioeconomy and Governance programme, Forest Science and Technology Center of Catalonia (CTFC), Spain

[2] European Institute of Planted Forests (IEFC), France

[3] IUFRO Unit 4.04.04 "Sustainable Forest Management Scheduling" and University of Lisbon, Portugal

[4] IUFRO Unit 4.04.07 "Risk Analysis" and University of Toronto, Canada

[5] EUROMONTANA, Belgium

[6] Norwegian Institute for Bioeconomy (NIBIO), Norway

Learning from the past to better inform the future: integrated approaches to increase forest health and resilience

Our forests are under threat. Trees, woods and forests provide significant socio-cultural, ecological and economic benefits in gardens, urban and peri-urban streets and parks, local woodlands and commercial forests and the wider environment where trees play a vital role. Science has highlighted the exponential increase in the introduction and spread of invasive species due to the growth in trade and travel, the speed and volume at which they travel and the difficulties of protecting porous boundaries. Climatic changes have supported establishment of introduced pests and pathogens or explosions of native species pushing large swathes of forests to their limits of resilience. Human attitudes and actions play an important role in the future resilience of forests but tree managers face a difficult task in identifying the right approach to take when faced with ecological, social and political uncertainty. History has much to teach us. A holistic and interdisciplinary approach to promoting forest health requires multiple disciplines and perspectives and acknowledgement that different societies will favour specific approaches, but we can learn from each other. This session will embrace an historical perspective focusing on the evolution of different forest health management activities influenced by political and/or economic transitions, cultural transformations and societal trends. We seek to share stories of pest and pathogen management where the outcomes were considered successful or not so successful, why and what next. Examples will be given of the demise of chemical sprays as a traditional pest management tool due to growing societal opposition and demands to protect humans and biodiversity; the increasing backlash from indigenous communities towards western-centric approaches to forest protection that haven't worked; and the growing relationship between foresters and publics in the co-development of future forest management. Top-down management regimes are no longer considered acceptable despite their continued existence in some parts of the world. Instead, we recognise a shift towards an ethical and just approach involving a social license to operate where wider engagement is necessary to ensure that management approaches for forest health are resilient and acceptable. Our speakers will share their stories of lessons learned and we will end with an interactive panel session encouraging audience participation on approaches to co-designing a biosecure future.

Mariella Marzano[1] , Andrew Leibhold[2], Maartje Klapwijk[3]

[1] SERG, Forest Research, United Kingdom

[2] Northern Research Station, US Forest Service, USA

[3] Department of Ecology, Swedish University of Agricultural Sciences, Sweden

Long-term experiments to study the effects of silvicultural interventions and climate change on forest dynamics

Long-term forest experiments have been implemented and maintained for several decades around the world. The data collected are used to quantify the effects of silvicultural interventions, but also to understand climate change and natural disturbance effects on forest dynamics. The data may also be used to calibrate growth and yield models as tools to project forest dynamics under future climates and management interventions. The cost and work of maintaining long-term forest experiments may make it difficult to establish new experiments or to maintain existing experiments. In this session, we invite researchers who have worked extensively with long-term forest experiments to present and discuss how they have used the data to address a variety of traditional and emerging forest management and conservation research questions. We further encourage researchers to present on successes and failures in establishing and maintaining long-term experiments to provide discussions and lessons learned. Exchange on good designs, pitfalls to avoid, and on how to secure funding among other things may allow future efforts in other regions to thrive by capitalizing on best practices of long-term forest experiments established around the world.

Bianca Eskelson[1] , Sileshi Weldesemayat[2], Guillermo Trincado[3], Christina Staudhammer[4]

[1] Forest Resources Management, University of British Columbia, Canada

[2] Addis Ababa University, Addis Ababa, Ethiopia

[3] Universidad Austral de Chile, Chile

[4] University of Alabama, United States of America

Managing Forests for of Multiple Ecosystem Services under Changing Climate

Forests are one of the planet's critical life supporting ecosystems. Multipurpose forest management systems over large forest landscapes aim at providing appropriate options to various stakeholders such as private forest owners for increased incomes, graziers for access to larger amounts of more nutritious feedstocks, state-owned forest farms for revenues and increasing forest resources, the local governments for sustainable forest resources and associated ecosystem services, the national governments for meeting their obligations under international treaties like the UNFCCC, UNCCD and CBD, while also meeting the general public expectations of good aesthetics and a healthy environment. Even as the expectations from the forest management systems to produce more of these ecosystem goods and services are rising, the changing climate is causing fundamental disruptions in the ecosystems, the extent and the direction of which is still largely unknown.

The valuation of various goods and services, which would be produced from these dynamically adaptive management options over the coming decades, is important to enable different stakeholders to make choices optimizing or balancing the multiple functions of forests. In the proposed session, we invite contributions on the following topics as pertaining to forest ecosystems worldwide:

- State of the knowledge of the multipurpose forest management options and valuation of forest ecosystem services from those options over time;
- Impact of climate change related emerging ecological, socio-economic and political issues on ecosystem services valuation and the key challenges introduced by climate change in the valuation processes;
- Impact of multipurpose management concepts and options on ecological structures and interactions in forests, and how these are linked to specific ecosystem services;
- Case studies of management options for multiple services in private, community owned, and state-owned forests.

Shuirong Wu[1, 2]

[1] Chinese Academy of Forestry

[2] University of Natural Resources and Life Sciences (BOKU)

Needle diseases of conifers: a globally rising threat to natural and planted forests

The damage caused by foliar pathogens in coniferous forests is on the rise globally, causing severe concerns for the management of both planted and natural forests. While some pathogens are host specific, such as the causal agent of Swiss needle cast on Douglas fir, others, such as those in *Dothistroma* or *Lecanosticta*, colonize a variety of hosts. Regardless, they are causing sporadic outbreaks across the globe, likely due to climate change or the mostly accidental introduction of new strains into areas. Despite the numerous species that can be classified as needle diseases (e.g., those in the genera *Coleosporuim, Dothistroma, Lecanosticta, Lophodermella, Lophodermium, Passalora, Phaeocryptopus*, and *Rhizosphaera,* just to name a few), they have many traits in common, even across those colonizing different host species, and current research on needle diseases can benefit from exchanging experiences from different systems. This session will cover and welcome a broad range of topics related to both pathogens and endophytes of needles, including their origin and dispersal, their geographic distribution, management options, the differential susceptibility of their hosts, and their resistance mechanisms. We will also cover current advances in pathogen genomics and population genetics, as well as diagnostics.

Irene Barnes[1] , Michelle Cleary[2], Caterina Villari[3]

[1] Department of Biochemistry, Genetics and Microbiology, Forestry and Agricultural Biotechnology Institute (FABI), South Africa

[2] Southern Swedish Forest Research Center, Swedish University of Agricultural Sciences (SLU), Sweden

[3] Warnell School of Forestry & Natural Resources, University of Georgia (UGA), USA

Never waste pandemics: lessons learned from past forest disease outbreaks

Disturbances, whether abiotic or biotic in nature, are integral and necessary components of forest ecosystems. However, anthropogenic pressures and climate changes have contributed to the erosion of forest ecosystem resilience, frequently to a degree that the tipping point has been breached, this causing devastating consequences across landscapes, countries and even continents. With globalization and changes in climate patterns, both natural and planted forests are at risk from invasive exotic pathogens, which are exacerbated by extended drought cycles, extreme precipitation events and air pollution. As an example, owing to the scale of pandemic destruction, Ash dieback, Dutch Elm Disease, Chestnut Blight, along with White Pine Blister Rust, are, so far, among the most catastrophic biotic disturbances in forest. The list of devastating disturbances is long and novel drivers will keep arising in the globalized world due to ongoing climate warming. Experience so far tells that it is less costly to conserve nature than it is to restore it, so it is imperative we learn from experience to protect forests now.

Our future relies on maintaining the ecosystem services provided by forest. The ongoing transition from a fossil fuel–based economy to a biobased economy is driven by the need to combat climate change, to protect the environment and to increase sustainability. This means we aim to meet the needs of the present generation without compromising the ability of future generations to meet their needs. When governmental roadmaps towards more carbon–neutral economies are drafted, the focus, concerning forests, is often only on the increase of forested area and management practices that facilitate forest growth. The underlying assumption is that forests are healthy and in different phases of growth, a demography that allows the balancing needed between carbon sequestration and a continuous flow of the biogenic material needed. However, pest and pathogen outbreaks, as history has shown, can severely disrupt our ambitions.

In this session, we welcome presentations that address how the underlying ecological, societal and institutional drivers have contributed to the rise and scale of specific disturbances. We hope to highlight assessments of currently implemented strategies considering the lessons learned from past pandemic crises. Similarly, we hope to outline management and policy options that are not yet in force or which have not yet attained that are not yet in place or not yet as but that would be needed to successfully prevent and/or to circumvent future pandemic crises.

Ari Hietala[1] , Nicola La Porta[2]

[1] Department of Fungal Plant Pathology in Forestry, Agriculture, and Horticulture, Norwegian Institute of Bioeconomy Research (NIBIO), Innocamp Steinkjer, Steinkjer, Norway

[2] IASMA Research and Innovation Centre, Edmund Mach Foundation, Trento, Italy. - The EFI Project Centre on Mountain Forests (MOUNTFOR), Trento, Italy.

New challenges for forest soil resources in the face of growing global demands for forest products and the need to limit global temperature increase

The global population is expected to reach 9.8 billion by 2050. To meet growing global demands for timber, fibre, and bioenergy in 2050, the current forest harvest will need to more than triple to 10 billion m^3 $year^{-1}$. Achieving this level of harvest will require several things to happen in the next 30 years. It is clear that forest soil resources will be central to ensuring this level of harvest from existing forests. Firstly, production from existing forests will need to increase. However, the future productivity of these forests is constrained by our current management options with respect to genetic resources, fertilizer practice and management of soil resources. New management approaches are urgently required to increase the supply and efficient use of forest soil resources to underpin greater levels of forest productivity. The area of plantation forests will also need to increase from the current level of 132m ha. Some scenarios predict at least 400m ha of plantation forests will be required to meet future demands. Not only will these forests need to be more productive if they are to contribute to the timber harvest in 2050, they will also need to be managed sustainably to ensure that they deliver the full suite of benefits and continue to act as large sinks and stores of carbon. At the same time, thirty years is not long in the life of a forest, or for that matter, long lived tree species. How fast do we need to go with respect to our current management? More importantly, can we go fast enough? Will it be fast enough to ensure forests and forest soil management adapt to the pressures of an ever-changing world, including the impacts of climate change? Finally, can it be done in sustainably?

These are new questions for the forest soil research community, and the answers will be critically important as the world rises to the challenge of avoiding global temperature increases by 2050. Potentially all aspects of forest management may need to change, resulting in shorter rotation lengths, more frequent and larger harvesting impacts, more intensive site preparation techniques, and greater use of inputs such as fertilisers, herbicides, pesticides and other chemicals. Most importantly, these forests will need to meet the multiple needs of forest communities, consumers, and nations? This session will explore these issues with a view to setting a new forest soils research agenda.

Peter Clinton[1] , Liisa Ukonmaanaho[2], Tom Fox[3]

[1] New Zealand Forest Research Institute Ltd, trading as Scion

[2] Natural Resources Institute Finland, LUKE

[3] Rayonier Inc

Nitrogen Depositions in a changing climate: Trends and Implications on Forest Ecosystem Services

As considerable components of global change, air pollution and climate change are major threats to forest health. Continuous and high anthropogenic nitrogen (N) emissions and resulting atmospheric N deposition are known to affect forest ecosystems and their services significantly. Although N is an essential nutrient for plants, the continuous N input will result in eutrophication, acidification and nutrient imbalance in plants, leading to increased sensitivity to secondary stresses – especially in areas, where N deposition exceeds the threshold of critical loads to forest sites. However, climate change has become an additional factor in the last decades, increasing the pressure on forest ecosystems. As a consequence, climate change indicated by high temperatures, prolonged droughts, and an increasing frequency of extreme events is expected to modulate the effect of N deposition on forest ecosystems.

Research projects and monitoring programmes, such as the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) and the Acid Deposition Monitoring Network in East Asia (EANET), are increasingly observing the combined impact from elevated N deposition and climate change affecting forest vulnerability. To strengthen forest resilience and to develop mitigation and adaptation measures, the cause-effect-relationships between N deposition, climate change, and forest ecosystem functioning need a more profound understanding of the single and combined effects and the underlying processes.

This session focuses on forest ecosystem services such as biodiversity, carbon sequestration, water recharge and purification and timber provision in a changing climate, and how to protect these services by adaptation strategies in forest management. Since the characteristics and the magnitude of N deposition and climate change vary globally, the session welcomes contributions from long-term monitoring and research networks worldwide, such as networks under the UNECE Working Group on Effects, ICOS, eLTER, EMEP and EANET. Our goal is to stimulate an inspiring exchange on N management in future forests, integrating information from the range of monitoring networks allowing for a whole system approach.

Nathalie Cools[1] , Anne-Katrin Prescher[2], Arne Verstraeten[1], Marcus Schaub[3], Lars Vesterdal[4], Kai Schwärzel[2], Hiroyuki Sase[5]

[1] Research Institute for Nature and Forest (INBO)

[2] Thünen Institute of Forest Ecosystems

[3] Swiss Federal Research Institute WSL

[4] University of Copenhagen

[5] Asia Center for Air Pollution Research

Old-growth forest ecology and management

Old-growth forests are broadly defined as forests that have attained great age, with multiple aged trees and usually multi-layer structure, with no or minimal human disturbance. Worldwide, from the tropics to the boreal zone, old-growth forests contribute disproportionately to biodiversity, carbon storage, esthetics, and other services. We propose a session to discuss the working definition, ecology, use, and protection of old-growth forest. Old-growth status implies forest stasis, but how are old-growth forests changing due to continuing forest maturation, climate change, fragmentation, natural extinction and immigration of species, and other factors? Can we distinguish natural, background change from anthropogenic change? Is use of a forest for production compatible with old-growth status? How much use for recreation is compatible with old-growth status? In fact, many answers to these questions depend on forest type and location. For example, definitions of old-growth using tree size will differ between tropical wet forests and boreal forests; permissible recreation will depend on local human population density.

The session will open with a couple of key questions for the audience to keep in mind. We hope session presenters will emphasize old-growth forest definition, forest change, and forest protection. We especially want concrete examples of change and challenge in old-growth forest that suggest a basic approach to making local policies for protection. We will close the session with a short discussion on the application of the presentations to the future of our old-growth forests. We welcome associated posters for this session.

Nicholas Brokaw[1] , Jonathan Onyekwelu[2], Michael Gebreslasie[3], Khosro Sagheb-Talebi[4, 5]

[1] Department of Environmental Science, University of Puerto Rico, Puerto Rico

[2] Department of Forestry and Wood Technology, Federal University of Technology, Nigeria

[3] Department of Environmental Sciences, University of KwaZulu-Natal, Durban, South Africa

[4] Research Institute of Forests and Rangelands, Iran

[5] Deputy coordinator, IUFRO Div. 1 Silviculture, Dep. Coordinator, IUFRO, Unit 01.05.00

Optimizing Agroforestry carbon stocks estimates

Recognition of Agroforestry's contribution to climate change mitigation is on the rise in climate talks, policies design and accounting schemes. Yet, its estimates are limited by a high level of uncertainty associated with the data used in the models. To address the gaps in Agroforestry-based allometric equations, forests models are often used. However, growth patterns are unknown for most of the species and management practices are not accounted for in these models. Furthermore, rigorous monitoring protocols that account for variability are often not implemented. Improving biomass and carbon estimates in Agroforestry systems is urgently needed to increase the integration into policy.

This session will highlight key root causes of the uncertainty of the current agroforestry estimates and focus on highlighting successful, cost-effective, rigorous solutions (innovations and initiatives) dedicated to collection, management, and production of robust and relevant Agroforestry-specific data. Success stories can include solutions at various stages: 1) Currently or recently implemented or 2) Being conceptualized.

This session has a hybrid format, and which will set the scene with an initial problem statement by the moderator followed by a series of 5-minutes speed talks highlighting solutions. Here presenters will answer i) how their solution is improving agroforestry estimates; ii) what are the main features (accessibility, scale of relevance and of implementation, potential users, and replicability); iii) how it is a gamechanger; iv) what is needed to take it to scale. The speed talk session will be followed by a panel to discuss ongoing initiatives, opportunities, and challenges to build (regional/biome/climatic) open-source repositories for Agroforestry carbon-relevant data to satisfy growing initiatives for scaling climate change interventions. To conclude, a poster session will be opened to deepen the understanding of the current basket of solutions, to stimulate networking, and encourage the scaling of solutions.

Marta Suber[1] , Iris Roitman[2], Martin Meier[2], Saulo Souza[2], Leigh Winowiecki[3]

[1] CIFOR-ICRAF, Peru

[2] CIFOR-ICRAF, Brasil

[3] CIFOR-ICRAF Nairobi

Prestoration – combining restoration and adaptation – of European forests for people and planet

There is wide agreement on the need for forest restoration for the conservation of forest biodiversity and provision of ecosystem services. Similarly, with increasing disturbance rates, there is little doubt about the urgency of forest adaptation to climate change. Too rarely, these two major challenges are brought together, and the implications of this double challenge on predominant concepts discussed. Furthermore, the practice side is increasingly lost amidst the diverging expectations both from policy side and society on the role of forests to protect biodiversity, adapt societies to global change and mitigate the impacts of climate change including through forest-based products. At the same time, the finance sector is more than ever ready to invest into nature and green solutions, however there is large uncertainty about the quality and long–term benefits of investment opportunities, how to credit these, and how to effectively bring the large demand for investment opportunities and the widespread but dispersed need for locally-adapted prestoration (restoration combined with adaptation) actions together.

The Horizon 2020 Green Deal project '*SUPERB - Systemic solutions for upscaling of urgent ecosystem restoration for forest related biodiversity and ecosystem services*' (2021-2025) is the largest forest-related project ever funded by the European Commission. With 36 partner organisations supported by an even larger number of associated partner organisations from across major stakeholder groups SUPERB demonstrates together with local stakeholders adaptive restoration actions in 12 large-scale demonstration areas. These demos represent not only the diversity of stressors on European forests and the wide range of necessary restoration actions but also different socio-ecological contexts including people's manyfold needs for ecosystem goods and services. To create lasting transformative change towards large-scale restoration SUPERB fosters an enabling environment for future-oriented forest restoration by increasing societal awareness and support, synthesizing and making easily accessible practical and multi-disciplinary scientific knowledge through a stakeholder-targeted Restoration Gateway and creating a large and powerful multi-stakeholder network and movement for the development, uptake, and upscaling of transformative forest restoration approaches and actions.

Elisabeth Pötzelsberger[1] , Gert-Jan Nabuurs[2], Iciar Alberdi[3], Thomas Lundhede[4], Marcel Hunziker[5], Jürgen Bauhus[6], Jo O'Hara[1, 7]

[1] European Forest Institute (EFI), Bonn, Germany

[2] Wageningen University and Research, P.O. Box 47, 6700 AA Wageningen, the Netherlands

[3] Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria, Consejo Superior De Investigaciones Científicas, Ctra. A Coruña km 7.5. 28040 Madrid, Spain

[4] University of Copenhagen, Department of Food and Resource Economics, Rolighedsvej 23, 1958 Frb. C, Copenhagen, Denmark

[5] Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Research Unit Economics and Social Sciences, CH-8903 Birmensdorf, Switzerland

[6] Freiburg University, Faculty for Environment and Natural Resources, Institute of Forest Sciences, Tennenbacherstr. 4, 79106 Freiburg

[7] FutureArk Ltd., Edinburgh, United Kingdomn

Response of forest ecosystems to global change: Learning from experimental manipulations and natural gradient studies

Forest ecosystems are exposed to future changes in temperature, precipitation, radiation, air humidity, atmospheric carbon dioxide concentration and nitrogen deposition. Numerous field experiments manipulating single or multiple factors were performed during the past decades. Results of these experiments often depend upon the ecosystem types, site characteristics and the variations in the intensity, duration and combination of manipulations. Alternatively, numerous studies have been conducted along natural climatic gradients which, however, have rarely been linked to ecosystem experiments. In our session, we encourage novel contributions from both manipulative experiments and climatic gradient studies or a combination of both, encompassing biogeochemical processes, plant and microbial aspects to improve our understanding of the climatic control on forest ecosystem processes. Contributions synthesizing experimental output and providing better, holistic process understanding are highly welcome.

Andreas Schindlbacher[1] , Frank Hagedorn[2], Werner Borken[3], Hui Wang[4]

[1] Austrian Research Centre for Forests - BFW

[2] Swiss Federal Institute for Forest, Snow and Landscape Research - WSL

[3] University of Bayreuth, Germany

[4] Chinese Academy of Forestry

Restoring degraded riparian ecosystems: Context matters

Forests, especially those in riparian zones influence water resources in multiple ways. It is estimated that forested watersheds provide over 75 percent of the world's freshwater resources, and more than half of the global population depend on water resources for various purposes. In addition, forests within riparian zones are integral components of the water cycle – regulating stream flow, fostering groundwater recharge and contributing to atmospheric water cycling. Riparian forests are also crucial for the long-term maintenance of downstream water quality by acting as natural filters, reducing soil erosion and water sedimentation (FAO, 2021).

Riparian forests are however, threatened by various human activities such as small-scale and industrial mining, hydroelectric projects, logging, small-scale agricultural expansion and large-scale agricultural projects. The loss of vegetation cover due to these disturbances can cause changes in the canopy with consequences for wildlife habitat, biodiversity, water flux and water quality (Sweeny et al. 2004; Wei et al. 2018; FAO, 2021) – ultimately affecting provision of water ecosystem services and water security.

Across the world, there are policy frameworks that support the maintenance and restoration of degraded riparian areas. Indeed, forest and landscape restoration approaches are regarded as promising tools to reverse the continual loss of riparian forests and other vegetation in riparian zones. Generally, it is estimated that restoration activities could lead to a reduction of 10 percent or more sediments and nutrients in watersheds (Abell et al. 2017). However, restoration and tree planting interventions may have variable impacts on watershed processes depending on which model is applied (Jones et al. 2020). For instance, agroforestry practices are known to significantly improve water filtration, soil organic matter and nutrient status. On the other hand, tree planting along degraded riparian areas could reduce steamflow and decrease water yield (Filoso et al. 2017).

These complex responses imply that outcomes of restoration efforts in riparian areas may be dependent on several factors including management regimes and tree species, and other governance related issues (du Plessis et al. 2022). Therefore, achieving success with restoration of degraded riparian ecosystems will require consideration of complex-mix of drivers, social actors and context.

This session, therefore, seeks to understand the key issues to consider when implementing restoration programs in riparian areas. The session will run as a side event to the proposed technical session "Transforming and restoring forest landscapes – showcases for a better future". The session will be held under Congress themes 1.2 and 1.3.

Shalom Addo-Danso[1] , Ernest Foli[1], Arthur Arnold Owiny[2], Adejoke Akinyele[3], Salamatu Shaibu[4]

[1] Forests and Climate Change Division, CSIR-Forestry Research Institute of Ghana, Ghana

[2] Uganda Christian University, Uganda, Deputy Leader: Forests, Soil and Water Interactions Thematic Group, FORNESSA

[3] University of Ibadan, Nigeria, Forests, Soil and Water Interactions Thematic Group, FORNESSA; Deputy Coordinator 2.08.00, Hardwood improvement, culture and genetic resources, IUFRO

[4] University of Bonn, Germany, Forests, Soil and Water Interactions Thematic Group, FORNESSA

Risk-based surveillance for quarantine forest pests

Ongoing globalisation results in increased introductions of non-native organisms in novel environments, mainly connected to trade activities. Some of these organisms can become forest pests, with devastating results. Globally, countries have implemented different schemes of national surveillance for invasive pests and pathogens. National Plant Protection Organisations (NPPOs) are responsible for the surveillance of pests in their countries, as well as their control (eradication, containment).

Preventing the introduction and spread of plants pests, is more cost effective than controlling and mitigating the impact of pests once they have established in a territory. To add to the unknowns, many invasive forest pests become only known to science after introduction in a novel environment. Identifying these threats beforehand (for example by using ex-patria sentinel plantings) is necessary to inform further steps. Furthermore, the pathways of introductions need to be investigated, for example by comparing global trade and invasion patterns, identifying hotspots for invasions and areas particularly suitable for the establishment and spread of invasive pests. Early warning systems (like trapping programs or in-patria sentinel plantings) can then be deployed to inform reactive management like quarantine and eradication efforts. It is of high importance that the benefits of the surveillance and management of quarantine forest pests outweigh the risks of an outbreak, which can be assessed using bio-economic models.

Different surveillance schemes are being developed for and by different countries. Especially on the international level, communication in between countries is limited, while the challenges and opportunities are similar internationally. This session's ambition is to inform and connect national surveillance schemes on an international level, and scientists that are working on the interface of research and implementation. It also aims to inform decision makers and risk assessors on:

1. Identification of future biotic threats before arrival
2. Identification of pathways
3. Implications for (inter)national measures for surveillance

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Benno Andreas Augustinus[1] , Maria Chiara Rosace[2], Andrea Battisti[3], Brett Hurley[4], Etsuko Shoda-Kagaya[5], Victoria Lantschner[6], Vittorio Rossi[2], Valentin Queloz[1], Eckehard Brockerhoff[1]

[1] Swiss Federal Institute for Forest, Snow and Landscape Research WSL

[2] Università Cattolica del Sacro Cuore, Piacenza, Italy

[3] University of Padova, Italy

[4] FABI, South Africa

[5] Forestry and Forest Products Research Institute, Japan

[6] INTA-CONICET, Argentina

Securing multiple ecosystem services from mountain forests

Mountain forests are facing particularly drastic changes in climate and related natural hazards. At the same time, healthy and resilient mountain forests are vital for local ecosystems and the environment in the lower elevations due to the many ecosystem services these forests provide. Beyond biomass and timber production, protection against gravitational hazards (such as rockfall, snow avalanches, erosion, and flooding), mountain forests represent a habitat for game and other faunistic and floral species, provide pastures for life stock as well as an environment for recreation. While such services usually rely on targeted management, the demand to mitigate climate change fostered arguments to set aside mountain forests as carbon sinks. Increasing intensities of disturbances and altered disturbance regimes (e.g., bark beetles in mountain forests in Europe and North America) impose threats to the sustainable delivery of the various ecosystem services provided by mountain forests. The need to balance post-disturbance management and pro-active measures to increase the stability and resilience of mountain forests while fostering the adaptive capacity to cope with future climatic changes is a core challenge in securing multiple ecosystem services from mountain forests. The proposed session will shed light on emerging situations in mountain forests worldwide and discuss possible approaches to maintain and secure the delivery of ecosystem services in the future.

Manfred Lexer[1] , Ivan Kunes[2], W. Keith Moser[3]

[1] University of Natural Resources and Life Sciences, Vienna (BOKU)

[2] Czech University of Life Sciences Prague, Faculty of Forestry and Wood Sciences

[3] USDA Forest Service, Rocky Mountain Research Station, Flagstaff, AZ

Silviculture of boreal forests in the face of climate change

Climate change is expected to modify the patterns of species distribution, natural disturbance regimes, and forest ecosystem structure and functioning in boreal forests throughout the world. These global changes can affect forest health and ecosystem services and compound the effects of anthropogenic disturbances such as logging. In some cases, large-scale application of even-aged systems may alter a forest's structure, and consequently, its resilience to stress and biodiversity. Diversifying management practices and silvicultural systems at various scales through disturbance-based management or continuous-cover forestry could be part of the solution. Adopting mixed-species silviculture in boreal forests could also help to improve boreal forest resistance and resilience to stressors. Nevertheless, many questions remain regarding boreal forest management in the context of global change, particularly regarding ways to conciliate multiple—and sometimes contradictory—objectives such as wood production, wildlife habitat management, biodiversity conservation and carbon sequestration. To face this uncertainty, forest owners and managers need more guidance and tools to support their decisions. This session aims to present the state of the art in boreal forest management and silviculture in the face of climate change.

Patricia Raymond[1] , Erika Olofsson[2], Saija Huuskonen[3], Ignacio Barbeito[4], Miguel Girona Montoro[5]

[1] Ministère des Forêts, de la Faune et des Parcs du Québec

[2] Linnaeus University

[3] Natural Resources Institute Finland

[4] University of British Columbia

[5] Groupe de Recherche en Écologie de la MRC Abitibi-(GREMA)

The biosecurity risks of international movement of tree seeds

Tree seeds have been considered as a minor introduction pathway for pests (i.e., insects and fungi) in comparison with seedlings. Consequently, tree seeds are often exempt from the existing restrictions that aim to mitigate the risk of pest introductions, although the regulations vary across countries. Tree seeds have shown to carry pests that may pose immense danger to natural forests and nursery stock with consequences to forest biodiversity and state's economy. Some tree seed pests may be biologically predisposed as good invaders because they can stay dormant for long periods of time while showing no signs of presence in seeds and thus easily stay unnoticed during inspections. This however might differ between insects and fungi, and between pests specialized on angiosperm and gymnosperm hosts. Although the risks of pest introductions via seed movements seem to be significant, there is a lack of knowledge required for a proper risk assessment, especially when considering the changes in the global trade volumes, routes as well as the impacts of climate change. This session aims at gathering contributions from entomologists, phytopathologists and other seed specialists working with gymnosperm and angiosperm seeds that might help to improve the assessment of the biosecurity risks associated with seed trade. More specifically, we aim at covering topics related to: volumes and directions of international tree seed movements, international legislation for tree seed exchange, the diversity of tree seed pests, tools and methods for their detection, as well as the topics related to different aspects of the ecology of tree seed pests that might be relevant for their introduction, establishment and spread/impact in times of global change.

Iva Franic[1] , Ana Perez-Sierra[2], Marie-Anne Auger-Rozenberg[3], Thomas Boivin[4], Michelle Cleary[5], David Kolotelo[6], Olle Rosenberg[7]

[1] Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Alnarp, Sweden

[2] Forest Research, Surrey, United Kingdom

[3] Forest Zoology Research Unit, French National Research Institute for Agriculture, Food and Environment (URZF INRAE), Orléans, France

[4] Research Unit Ecology of Mediterranean Forests, French National Research Institute for Agriculture, Food and Environment (URFM INRAE), Avignon, France

[5] Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Alnarp, Sweden

[6] BC Provincial Tree Seed Centre, Ministry of Forests, Surrey, Canada

[7] Swedish Forestry Research Institute (Skogforsk), Uppsala, Sweden

The Pine Wilt Disease dramatic impact on conifers forest across the world, today and in the future

The Pine Wilt Disease (PWD) caused by the Pinewood Nematode (Bursaphelenchus xylophilus) is the major threat for conifer forests worldwide. Native from the Eastern North America it was accidently introduced in Japan in early 1900's and in the late 20th century it spread, first to neighboring countries of Korea and China, and later reached Portugal (Europe). Wherever it was introduced by global wood trading causes the mortality of thousands of pines every year, although dedicated research improved the knowledge about this complex system that involves apart from the PWN and susceptible tree hosts an obligatory insect-vector, of Monochamus genus, that transfers the nematode from an infested death host to the healthy surrounding forest.

The sessions on the PWD will focus on the following themes:

- State-of-the-art on the PWD system, with knowledge developed on each of all components (nematode, host tree, insect-vector, associated microorganism) and their interactions that allow the disease development and expression, the different parts of the world, from native to introduced regions;
- Economic and social impact evaluation and control measures already developed to mitigate its impacts (insect-host trapping, host trees eradication and breeding for resistance etc.) and future prospects and recommendations.
- PWD models for predictions at short or long-time horizons.

Each session with 120 minutes, will start with a sub-plenary talk by an invited speaker, followed by oral presentations. There will be a fourth and final interactive session near dedicated Posters, followed by a panel discussion on-site

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Luís Bonifácio[1, 2], Christelle Robinet[3], Hyerim Han[4], Katsunory Nakamura-Matori$_5$, Jianghua Sun$_6$

[1] INIAV - National Institute for Agrarian and Veterinary Research, Portugal

[2] Green-it - Bioresources4Sustainability, Portugal

[3] INRAE, France 4 National Institute of Forest Science, Korea

[5] Forestry and Forest Products Research Institute, China

[6] Institute of Zoology, Chinese Academy of Sciences, Japan

Transitioning to Continuous Cover Forestry in Times of Climate Change and Energy Crisis

Continuous Cover Forestry (CCF) is forest management based on ecological principles with a view to avoid degradation effects. Throughout the world and in the literature the concept goes by many semi-synonyms which do not exactly mean the same but are headed approximately into the same direction. For example, one of these semi-synonyms is nature-based forest management. CCF has a long history in Central Europe but is comparatively new to other parts of the world. Currently the popularity of CCF is on the increase again for its potential to mitigate climate change, to increase or at least maintain biodiversity in forest ecosystems, to provide valuable tools for forest conservation and to enhance the appeal of woodlands used for recreation. Recently the EU forest strategy for 2030 stated clearcutting should be "used only in duly justified cases, for example, when proven necessary for environmental or ecosystem health reasons" and the strategy promotes "the creation or maintenance at stand and landscape level of genetically and functionally diverse, mixed-species forests." Early in 2022, the European Forest Institute (EFI) has launched a new strategy underpinning CCF principles with scientific evidence. It is particularly the early phase of transitioning towards CCF, i.e. the introduction of CCF to a country or region where this management type has not been commonly used before, which usually constitutes a major challenge for forest practice and stakeholders. For example, this was the situation 20 years ago in Ireland and in the UK and CCF is now being considered for introduction in the congress host country Sweden. A long-standing and crucial question is how natural disturbances can be more directly included in the design of CCF methods. The recent global energy crisis has added another challenging facet to implementing CCF and methods like the coppice selection system and coppice with standards may now assume greater importance than they did in the past. A topic close to the heart of forest practice is the important question how, in the context of these current challenges, the sustainability of ecosystem goods and services can be ensured in CCF and its variants. Effective methods of safeguarding ecosystem goods and services may, for example, require forest inventory designs to be adopted.

Arne Pommerening[1] , Aine Ni Dhubhain[2], Jørgen Bo Larsen[3], Per Angelstam[4], Hubert Hasenauer[5]

[1] Department of Forest Ecology and Management, Swedish University of Agricultural Sciences SLU, Sweden

[2] School of Agriculture and Food Science, University College Dublin, Ireland

[3] Department of Geosciences and Natural Resource Management, University of Copenhagen, Denmark

[4] School of Forest Management, Swedish University of Agricultural Sciences SLU, Sweden

[5] Department of Forest and Soil Sciences, University of Natural Resources and Life Sciences, Austria

Use of RNA strategies for the control of forest pests and diseases: mycoviruses and interfering RNA

The search for environmentally-friendly products for plant disease management is a priority worldwide, and environmental RNA interference (RNAi) offers a promising solution. RNAi is a gene regulatory system, conserved in eukaryotic organisms, that silences the expression of certain transcripts via double-stranded RNA (dsRNA) processing. Environmental RNAi is a phenomenon by which dsRNAs can be taken up from the environment and induce systemic gene silencing in target organisms. On the other hand, mycoviruses or fungal viruses are widespread in all major taxa of fungi. They have mostly dsRNA (double-stranded RNA) genomes, but an increasing number of positive or negative ssRNA (single-stranded RNA) and ssDNA (single-stranded DNA) viruses have been isolated and characterized in recent years. The session will deal with those two environmental-friendly methodologies for forest disease management.

Jonatan Niño Sánchez[1] , Nobuhiro Suzuki[2], Julio Javier Diez Casero[1]

[1] University of Valladolid. Campus Yutera Edificio E, 34071 Palencia, Spain

[2] Institute of Plant Science and Resources, Okayama University, Kurashiki, Japan

Accounting for risks and uncertainties in forest-based businesses, sectoral projections, and policy design

Investments on infrastructure and production facilities in the forest-based industries like the decisions on forest management are often irreversible and having long-time consequences. These decisions must be made under various risks and uncertainties that can be of natural, biological, technical, economic and/or political nature, while some of them are simply epistemic. These uncertainties are also present in planning of climate, environmental and economic policies. Hence, they complicate the design of solid policies and evaluation of anticipated policy outcomes. Various techniques are available to account for the risks and uncertainties in economic decision making and policy planning. Moreover, increasing amount of data, even big data, are now allowed to be processed to model the reality and project the future in the business environment and the forest sector to provide better grounds for decision making. Yet, the data are seldom flawless, and the methods for testing and improving the data used for decision making are also needed

This session welcomes Ph.D. students, and early-career and senior scientist to present their applications on risks and uncertainty analyses related to the economics of forest management, forest-based business planning, forest sector model projections, and policy design. Presentations addressing the approaches and applications for identifying the value and importance of better data/losses due to incorrect data and methods for improving the solidity of the data used in decision making and analyses in the contexts above are also relevant. The presentations may be in form of oral, poster or flash-talk presentations.

Maarit Kallio[1] , Greg Latta[2], Francisco X. Aguilar[3], Peter Deegen[4]

[1] Norwegian University of Life Sciences, Faculty of Environmental Sciences and Natural Resource Management, Norway.

[2] University of Idaho, Department of Natural Resources and Society, United States.

[3] Swedish University of Agricultural Sciences, Faculty of Forest Sciences, Sweden.

[4] Dresden University of Technology, Germany

At the edge: (Il)legal and (il)legitimate

This session aims to collect, share, and disentangle the complex interlinkage between (il)legal and (il) legitimate activities in the forest supply chain and to identify major concepts relevant to describing this relationship, such as power, values and efficiency. It is based on the observation of an increasing expansion of illegal forest activities globally. These are described, on the one hand, as violations of regulations, property rights, and social justice; and with negative long-term effects on sustainable development. On the other hand, unauthorized or illegal activities are common, frequently morally accepted, and receive legitimacy. Furthermore, diverse types of governance systems seek to respond the challenge of illegal activities drawing on different types of legitimacy, but at the same time being criticized for lacking the same.

Presentations (in form of short pitches) draw from a range of perspectives, including international relations, public policy, forest governance, environmental/forest law or sociology; reflecting diverse theoretical and conceptual schools of thought relevant to these issues. These presentation will form the basis of panel discussions.

Peter Kanowski[1] , Daniela Kleinschmit[2]

[1] Fenner School of Environment and Society, The Australian National University

[2] Chair of Forest and Environmental Policy, University of Freiburg

Contribution of wood-based products to climate change mitigation: State-of-the-art and research directions

Forests play a key role in regulating the global climate through the emission and removal of biogenic carbon to and from the atmosphere. Besides maintaining and enhancing carbon sinks in forest ecosystems, the forest-based sector can contribute to climate change mitigation through substitution and product carbon storage impacts, which arise when wood is used in industrial applications, such as construction and textiles. As it remains one of the most uncertain components in determining the overall climate impacts of the forest sector, this session focuses particularly on the substitution impacts of wood use.

Substitution impact refers to the amount of fossil emissions avoided when wood-based products or energy are used in place of alternative products or energy carriers over their lifecycle. There is strong evidence that wood-based products are, on average, associated with lower fossil-based greenhouse gas (GHG) emissions than alternative products or energy carriers. However, literature indicates a trade-off between the short-term and long-term climate impacts of increased wood harvest compared to baseline, as the avoided fossil emissions and carbon stored in products seem insufficient to compensate for the temporary decrease in the forest carbon sink.

Quantifying the substitution impacts of wood use remains challenging due to the difficulty of selecting an appropriate baseline, and the challenge of finding relevant data on alternative substitution cases. Many simplifications are used to estimate market-level substitution, often relying on published values, and better data are needed to describe which wood product can replace which non-wood product, where and when, to what extent, and with which indirect price-mediated consequences. Life Cycle Assessments (LCA) and market data only exist for some of the well-established product groups, and these values are anticipated to change over time, due to the decarbonization expected by Paris Agreement targets. This creates a need for new data, tools, and approaches to assess the avoided fossil emissions attributed to changes in wood use, as well as the balance of biogenic and fossil emissions across different time intervals and in different contexts.

The session welcomes presentations particularly on i) methodological and theoretical advances in quantifying the substitution impacts of wood use at market/landscape level and ii) holistic analyses of the climate change mitigation potential of the forest sector with an emphasis on changes in wood use patterns.

Elias Hurmekoski[1] , Carolyn Smyth[2], Tobias Stern[3], Erwin Schau[4]

[1] University of Helsinki

[2] Natural Resources Canada

[3] University of Graz

[4] InnoRenew

Developing digital drivers for risk mitigation in forest supply chains

Climate change and biotic risks generate an increased uncertainty on the availability and characteristics of wood world-wide, causing profound disruptions downstream in the forest-based supply chains. Forest fires, windstorms and infestations often result in a large amount of salvage harvesting which must be processed quickly to avoid decay. At the same time site availability varies due changing weather and environmental impacts must be mitigated. This new situation requires reinforced robustness in operations planning along the supply chain, to react quicker and more effectively to unplanned events. This entails reallocating capacity and redirecting flows and stocks for downstream production. The new sensors and data sources in the realm of Forest 4.0 will be the digital drivers to provide the required information in-time. However, further intelligence is needed to combine data from multifold sources for monitoring, triggering "early-warnings" and setting-up the most adequate supply chain response. These digital drivers need to consider not only the recorded data but provide solutions for predictive analytics, collaborative response and optimal supply chain design for the various forest and risk types in different regions of the world. Climate-driven risks to supply are of immediate concern, but also market risk must be considered when developing increased value chain resilience. Therefore, this session is a chance to present and discuss innovative digital architectures and solutions for forest supply chain management, as a common response strategy to forest related data and forest supply chain risk across the world. We intend to bring together researches and case studies in order to share their experiences. The specific goal of the session is to develop a generic framework for evaluating resilience in wood supply, complete with general quantitative approaches, KPIs and decision support.

Key-words: climate-driven risks, data, interoperability, resilient value chains, visibility, decision support.

Alexandra Marques[1] , Gert Andersson[2], Taraneh Sowlati[3], Dag Fjeld[4]

[1] FORESTWISE - Collaborative laboratory for integrated forest & fire management, Portugal

[2] Skogforsk - Forestry Research Institute of Sweden, Sweden

[3] Dept. of Wood Science, University of British Columbia, Canada

[4] Swedish University of Agricultural Sciences, Sweden

Economics of forest plantations in Latin America: advances, challenges and opportunities

This group proposes to present the current stage, the main advances, challenges, and economic opportunities of planted forests in Latin American countries. Latin America's countries present different realities regarding planted species, destinations of these plantations, and therefore management, as well as different levels of development in terms of research, business organization, and regulations. The comparison of the current state of these realities and the challenges that each of the forestry sectors of the countries faces will allow us to analyze the role of Latin America in the forestry value chains worldwide. Furthermore, among the opportunities, the session introduces recent topics that are in discussion worldwide and specifically in Latin America such are bioeconomics and the combination of forestry with other productive activities. The changes that countries in Latin America are facing regarding the management of their forest resources with a focus on plantations will be presented from private and public sectors´ experiences.

Vitor Afonso Hoeflich[1] , Virginia Morales Olmos[2], David Alexandre Buratto[1], Zenobio Abel Gouvêa Perelli da Gama e Silva[3]

[1] Universidade Federal do Paraná, Brazil

[2] Universidad de la República, Tacuarembó, Uruguay

[3] Universidade Federal do Acre, Brazil

Ensuring healthy trees for high quality wood products

The production of high quality forest products is directly reliant upon desired raw material quality, i.e. disease-free, clear wood harvested from healthy trees. When stems are infected by forest pathogens, end products can be compromised by inferior wood, or the production cycle suffers unacceptably high levels of waste creation. Infection of non-merchantable parts of the tree, such as foliage, result in decreased overall productivity, leading to increased rotation length and an extended period between planting and harvest. For these reasons, forest pathologists in Division 7 and wood scientists in Division 5 have come together in this session to discuss how to optimize wood production for the future forest products. Topics that will be discussed include canker pathogens of commercial species and the assessment of defect, non-destructive testing to detect heart rot within commercially important trees, the effects of foliar pathogens on growth and how to mitigate losses, assessment of degrade, industrial processes to optimize production from inferior wood, and the planting of resilient forests that can withstand the anticipated effects of climate change and stress. We have suggested a diverse group of speakers from both divisions that are able to examine this issue from different perspectives but are united in their desire to optimize forest productivity.

Isabel Munck[1] , Pekka Saranpaa[2], Tod Ramsfield[3]

[1] USDA Forest Service

[2] Natural Resources Institute Finland

[3] Natural Resources Canada, Canadian Forest Service, 5320 122 St NW, Edmonton, AB, T6H 3S5, Canada

Fast growing trees in support of sustainable bioeconomy

Fast-growing trees are trees with a mean annual increment of at least 10 m^3 per ha, although the meaning of "fast" varies widely depending on species traits, climate, soil and other biotic and abiotic conditions, as well as cultural practices. Warmer climates often facilitate the cultivation and rapid growth of many fast-growing tree species, while only a few of them are suitable for cooler and colder climates. Fast-growing trees are cultivated in traditional silvicultural systems, short-rotation coppice systems and agroforestry systems.

Fast-growing trees are widely used throughout the world for the production of timber, pulp, biomass for bioenergy and other forest products. They also recently gained recognition for the ecosystem services they can provide, including erosion control, soil fallow, carbon sequestration and freshwater flow protection.

With the consumption of primary processed wood products expected to increase by 37 percent by 2050 (compared to an increase of only 28 percent over the past 30 years, despite a lower expected population growth rate), fast-growing trees will play a key role in fulfilling the demand for wood products in the context of an increasing global population. They will be critical in the transition towards a carbon-neutral economy as they provide low-carbon renewable products, which can be substituted for carbon-intensive products.

This session will enhance knowledge on the contribution of fast-growing trees to the bioeconomy through the provision of wood and other ecosystem services; share promising practices to sustainably increase their production while meeting environmental and socioeconomic objectives; and raise awareness on the role of the International Commission on Poplars and Other Fast-Growing Trees Sustaining People and the Environment (IPC).

Thais Linhares Juvenal[1, 2] , Faustine Zoveda[1], Martin Weih[2, 3]

[1] Food and Agriculture Organization of the United Nations (FAO)

[2] International Commission on Poplars and Other Fast-Growing Trees Sustaining People and the Environment (IPC)

[3] Swedish University of Agricultural Sciences

Fast-Growing Trees for a Greener Future: Global Applications of Nature-Based Solutions

Anthropogenic activities and climate change have degraded global lands and waters in rural areas, urban centers, and all landscapes in between. These human-caused impacts have resulted in a need for technologies that restore ecosystem services of degraded landscapes and sustain livelihoods. Ecological restoration techniques, known as phytotechnologies, involve the strategic use of plants to solve environmental problems. Phytotechnologies are cost-effective, sustainable, long-term solutions that reduce land degradation, increase biodiversity, enhance ecosystem services (e.g., clean water, healthy soils, carbon sequestration), and improve human well-being (e.g., providing shade and aesthetics). Phytotechnologies are often classified according to one or more biological recovery activities: rehabilitation, restoration, reclamation, and remediation. Phytoremediation, the use of trees to clean contaminated soils and waters, is the most common phytotechnology implemented globally to accumulate, immobilize, metabolize, and/or volatilize pollutants. Other primary phytotechnologies include: mine reclamation systems, wastewater applications, constructed wetlands, rain gardens, green infrastructure plantings, and vegetative forest buffer agroforestry systems.

Fast-growing trees are particularly suited for phytotechnologies due to their rapid growth, enhanced productivity, and elevated sequestration of CO2 from the atmosphere. These purpose-grown trees can establish quickly on sites with disturbed soils, including agricultural areas, industrial landscapes, and degraded lands. Through provisioning of ecosystem services, eutrophication of watercourses can be avoided, conditions for slow-growing, climax species formed, and biodiversity substantially improved.

The proposed Fast-Growing Trees for a Greener Future session will be a diverse, timely exploration of the applications of fast-growing trees in phytotechnology systems around the world. Presenters will be selected to ensure equal representation among continents and will highlight challenges, achievements, and innovations of implementing fast-growing trees from their own research networks. Therefore, the oral presentations will provide a global perspective on the current state of fast-growing tree-based phytotechnologies. A panel session following the oral presentations will stimulate dialogue between presenters and session attendees. Students (undergraduate, graduate, and post-doctoral) will be encouraged to present lightning talks, in which they promote their research using one presentation slide and encourage people to visit their posters during the student poster session.

Through this technical session, we seek to enhance the information exchange about ecological restoration, reclamation, remediation, and other nature-based solutions using fast-growing trees. At the same time, we aim to facilitate the discussion on fast-growing tree-based systems as long-term solutions for increasing biodiversity conservation and resilience, improving ecosystem services, reducing global degradation of land, water, and air, and achieving many of the United Nations Sustainable Development Goals.

Ronald Zalesny[1] , Elizabeth Rogers[1], Ryan Vinhal[1], Marzena Niemczyk[2], Azadeh Salehi[3], Ismael Leonardo Vera Puerto[4]

[1] USDA Forest Service, USA

[2] Forest Research Institute, Poland

[3] Research Institute of Forests and Rangelands, Iran

[4] Catholic University of Maule, Chile

Forest to Food: Developing synergies across forest restoration, the bioeconomy and sustainable agriculture

A variety of precommercial and noncommercial silvicultural thinning treatments can be implemented to accomplish diverse forest management objectives. For example, in forests prone to severe wildfire, fuel treatments can be used to change fire behavior and reduce wildfire risk by removing vegetation and creating a stand composition and structure that is more resilient to wildfire. Similarly, thinning can be used to remove established or encroaching invasive species to restore native habitat to some reference condition. These treatments produce large amounts of woody biomass in the form of small-diameter logs and woody biomass residues that are often burned in place for disposal. However, biomass materials from thinning can be converted into bioproducts that can be used in agriculture, such as sawdust, wood shavings and biochar. South Korea and other countries use sawdust in animal bedding to protect water quality, improve animal welfare, and generate safe organic fertilizers that can be used in cultivation. Biochar is a charcoal soil amendment that can be made from woody biomass and used in fields and pastures to improve soil quality and reduce methane, nitrous oxide, and ammonia emissions, which are a significant contributor to local air pollution and total greenhouse gas emissions. Biochar can also be used in potting media and soils in greenhouses and is being developed as an additive to animal feed to reduce methane emissions and improve animal health. Greater integration of forestry and agricultural operations focused on providing agricultural inputs from low value forest waste biomass provides an opportunity to develop a new cohesive bioeconomy that will generate net social, economic and environmental benefits in these sectors. The purpose of this session is to bring together researchers and practitioners in different disciplines to share recent research advances on the production of forest bioproducts and their applications in agriculture. Our ultimate goal is to improve current agricultural practices related to waste management and sustainable production of food, while simultaneously supporting forest restoration through the sustainable use of small-diameter trees and woody biomass for agricultural inputs. We envision the agricultural sector serving as a market driver for bioproducts from these materials for such products as animal bedding, sorbent products, and soil amendments. Furthermore, the successful development of forestry and agricultural business clusters consisting of enterprises that are co-located and integrated can contribute to increased economic efficiency, sustainable agricultural production, reduced environmental footprints, and enhanced forest health and wildfire resilience.

Nathaniel Anderson[1] , Deborah Page-Dumroese[1], Han-Sup Han[2], Kas Dumroese[1], Jae-Heun Oh[3], Minjae Cho[3], Eunjae Lee[3], Ho-seong Mun[3], Sang-Kyun Han[4]

[1] Rocky Mountain Research Station, U.S. Forest Service

[2] Ecological Restoration Institute, Northern Arizona University

[3] National Institute of Forest Science, South Korea

[4] Kangwon National University, South Korea

Forest-based Bio-economy Prospects in Africa

Efforts to transition to a bio-economy are rapidly developing throughout Africa. South Africa published a strategy in 2013. In 2020, seven Eastern African countries came together to produce the first regional bio-economy strategy. While most bio-economy-related activities focus on bioenergy and biofuel production, some center on the unique forest biodiversity and commercializing knowledge about traditional bio-resources.

South Africa stands out as a leader in the transition to a bioeconomy. With a treasure trove of natural resources, and one of the highest levels of biodiversity in the world, South Africa's efforts have focused on these assets, and blended with health and medical aspects in its strategy. The country's strategy centers on bionnovations to generate sustainable economic, social and environmental development, encompassing biotechnologies for economic outputs that create jobs, enhance food security for a 'greener' economy.

This technical session provides a forum to explore challenges and opportunities for a forest-based bio-economy in Africa. It reflects efforts by the Africa Forest Forum (AFF), the Network for Natural Gums and Resins in Africa (NGARA), and the IUFRO Task Force "*Unlocking the Bioeconomy and Nontimber Forest Products*" to assess the prospects of a forest-based bio-economy. Presentations provide overviews of the status of bio-economy transitions, focusing on key commodities across the continent. The contributions of NTFPs to livelihood, food security, and household economies are explored. Presentations represent the state-of knowledge relative to a forest-based bio-economy. Participants in this session will come away from the session with a better understanding of what is entailed by a forest-based bio-economy in Africa.

Godwin Kowero[1], Marie Louis Avana[2], Doris Mutta[2], Ben Chikamai[3], Suzana Augustino[4], James Chamberlain[5]

[1] Executive Secretary, African Forest Forum

[2] Senior Programme Officer, African Forest Forum, Nairobi - Kenya

[3] African Forest Forum Governing Council Member and Executive Secretary, Network for Natural Gums and Resins in Africa (NGARA)

[4] African Forest Forum Governing Council Member, Chair AFF Members Forum and DVC Nelson Mandela University, Arusha - Tanzania

[5] IUFRO Task Force "Unlocking the Bioeconomy and Nontimber Forest Products", USDA Forest Service, USA

Forest-based sector in sustainability transformation: opportunities and sectoral impacts

While the forest-based industries and the markets they operate in have been changing substantially during the last decades, the transformation of the sector need to be even more drastic in the decades to come. Population and economic growth increase the demand for many products with consequential environmental challenges. The forest sector, being heavily dependent on land use, faces particular challenges due to its interactions with climate and biodiversity.

Forests' contributions to human well-being are multifaceted with forests, forestry and wood industries providing sets of concrete and intangible services. Sustainability can be measured and projected from various angles including sets of environmental, social, or economic indicators. Using the SDG as metrics, several sustainability objectives are conflicting and care has to be taken in designing policies to find right balance and to avoid undesired lateral effects.

The societies and consumers request that the forest sector may become more sustainable with lower impact on the natural environment. At the same time, renewable and sustainably produced woody biomass-based products are seeing growing demands to replace carbon-intensive products and other environmentally harmful materials. While such an operation environment is complex, it opens new opportunities for forest products and forest-based businesses. Breakthroughs in value-chain design, production processes, and in the use of raw materials are expected e.g., in the areas of chemicals, bio-based packaging, construction industries and textiles. Some of these may improve the sustainability and the competitiveness of these products and even the whole sector. These advances are typically coupled with smarter recycling and circular economy approaches that may aid in reaching the aim of sustainable and sufficient supply of resources, whether these are renewable or non-renewable.

The session calls for contributions that consider the opportunities discussed above and analyse and project the sustainability transformation within the wood-based bioeconomy as well as analysing trade-offs and synergies in forest sector ecosystem services supply. The studies may assess impacts of the sustainable, resource-smart transformation of the forest sector from various angles: environmental, ecological, sociological, political, economic, business, and systemic. Comparisons of value chains and their sustainability impacts are likewise relevant. The role of an emerging bioeconomy as a driver of change is explicitly part of the session's scope; thus, studies that consider emerging or niche value chains are welcomed. Quantitative studies will be given priority, but high-quality qualitative assessments will also be considered.

Hanne K. Sjølie[1] , Franziska Schier[2], Maarit Kallio[3]

[1] Inland Norway University of Applied Sciences

[2] Johann Heinrich von Thünen Institute

[3] Norwegian University of Life Sciences

Future biorefineries: forest biomass and side streams supporting circular economy

Global economies are looking for solutions to achieve the much-needed carbon neutrality and mitigating global warming. Forest biomass and various side streams from wood processing industry provide a range of monomers and macromolecules with great potential to replace fossil raw materials. A vast number of projects in all continents are developing biomass based biorefinery. However, it needs cross-sectoral and multidisciplinary partnerships to scale up such technologies and make them feasible.

Bioenergy and biomass-based products diversify the business opportunities in the forest cluster. In particular, biorefineries, which could be integrated into the saw mills and pulp and paper mills, seem to have immense future potential. The raw material quality requirements of wood and bark of future biorefineries may differ from those of the current industries. For traditional products, like solid wood and engineered wood, high density and strength is appreciated. Pulp and paper products have different quality requirements including fibre length and low lignin content. For each end use, logistics need to be tailored.

The session welcomes voluntary research presentations related the key characteristics of wood biomass that are relevant for different biorefinery processes. A special emphasis is put on scalability, economic feasibility, and resource availability while the challenges in the path toward the development of biorefineries are also discussed. Prehandling, transportation and storing of the feedstock for biorefineries will be also discussed.

Risto Korpinen[1] , Manuela Romagnoli[2], Pekka Saranpää[1]

[1] Natural Resources Institute Finland, Finland

[2] Tuscia University, Italy

Improving the flow of the reforestation pipeline to support regeneration and ecosystem function for the future

Forests around the globe provide a wide variety of ecosystem services. The need for increased forest protection, forest restoration, and adaptation of forest management to climate change is well established, yet global forest cover continues to decline. This has prompted many global, regional and national organizations to set targets for large-scale forest landscape restoration and reforestation. Examples include the Great Green Wall of the Sahara and the Sahel Initiative in Africa, The Bonn Challenge, and the One Trillion Trees Initiative. Additionally, the European Union (EU) Biodiversity Strategy 2030 includes a roadmap for planting at least 3 billion trees in the EU by 2030. Following the Declaration on Forest and Land Use from the United Nations Climate Summit (COP26) at Glasgow, 137 countries committed to collectively end forest loss and land degradation by 2030, which included funding pledges for forest restoration.

In many regions, significant land area is available for reforestation and restoration programs to help accomplish such initiatives. Nevertheless, successful large-scale restoration faces many challenges including costs, selection of appropriate species, a shortage of regeneration material, and continued maintenance following tree planting. Thus, to meet these ambitious tree planting goals, the steps in the "pipeline" for tree planting operations need to be scaled up.

In this technical session, we will present examples from around the world of how reforestation and restoration operations, as well as the communities that they support, are working collaboratively to help meet tree planting goals at local, regional, and global level. Based on the presentations we will identify critical weak links that exist in the flow of the reforestation pipeline and develop potential solutions to help overcome these in order to transform landscapes and reach reforestation and restoration targets.

Douglass Jacobs[1] , Juan Oliet[2], Karin Hjelm[3], Magnus Löf[3], Barbara Mariotti[4], Daniel Soto[5]

[1] Purdue University, USA

[2] Technological University of Madrid, Spain

[3] Swedish Agricultural University, Sweden

[4] University of Florence, Italy

[5] University of Aysen, Chile

Innovations and new business models towards more sustainable circular forest bio-economy, especially including life-cycle and techno-economic assessments

There is increased global and local concern about the disappearance of old-growth and primary forests, and the increased pressure toward managed forests in the maintenance of biodiversity, carbon budgets, and the provision of forest ecosystem services to fuel economic and social goals. The borders of forest industry are also in flux with the circular and bioeconomy policies shaping market environments and consumer behaviour. To address global challenges, there is a need for finding new levers of change toward social-ecological systems embedded in a circular bioeconomy, and here emerging circular bioeconomy refers to a system in which bio-based resources are utilised efficiently by using waste and side streams of industrial processes and reusing, recycling, and cascading bio-based materials. At the same time, we are in a need of gaining a better understanding of the multiple environmental services, and related conflicts that use of natural and managed forests provide, and the importance of balancing various societal needs.

We organize this highly multidisciplinary session to 1) strengthen the understanding of the role of innovations and new business models as a critical element towards creating a more sustainable circular forest bioeconomy, 2) to investigate the role that ecosystem services play for improving the livelihood of people including economic contributions, human health, ecological and social benefits of forests. Finally, 3) the scope of the session was chosen to better understand and quantify environmental impacts and to avoid possible negative effects of increasing wood use. Hence, we wish to incorporate the latest evidence from the life-cycle and techno-economic assessments of bio-based products in order to better understand environmental performance of materials and the sustainability performance of new products. As related mechanisms, developing product eco-labels, carbon footprints (CFPs) and environmental product declarations (EPDs) can be among novel value-addition strategies to influence consumer behavior.

Accelerating transformative sustainability change is much needed. We believe this session is important, as it addresses how ecosystem services and markets can better connect people with various functions of forests. Changing from a linear to a circular economy may also require reconsidering how value is created and captured among value networks and related stakeholders. Therefore, the session aims to foster thinking about ways and mechanisms for scholars and practitioners from wood and non-wood sectors may collaborate for advancing their knowledge, and how engagement of forest sector businesses can support meeting global sustainability goals.

Anne Toppinen[1] , Maciej Skorupski[2], Richard Bergman[3]

[1] IUFRO Research Group 5.10 Coordinator, Professor and Vice dean (Research affairs), University of Helsinki, Latokartanonkaari 7, 514, 00014 Helsingin yliopisto, Finland

[2] IUFRO Research Group 8.02.05 Coordinator, Poznan University of Life Sciences, Faculty of Forestry, Department of Game Managemen and Forest Protection, Uniwersytet Przyrodniczy w Poznaniu Widzial Lesny Katedra Lowiectwa i Ochrony Lasu ul. Wojska Polskiego 71 D 60 625 Poznan, Poland

[3] PhD, CC-P IUFRO Research Group 5.12 (Past) Coordinator, U.S. Forest Service, Forest Products Laboratory, United Sates

Innovations to support sustainability in non-timber forest products value chains

Nontimber forest products (NTFPs) play an increasingly recognized role in the forest and agroforest sectors. They are harvested by billions of people and commercial NTFPs contribute to rural incomes, livelihoods, businesses, and nutrition across all continents. NTFPs are traded in local, national, and global value chains and contribute to diverse and often enigmatic sectors, including culinary and functional foods, alternative herbal medicines, and floral decoratives, all of which are seldom recognized as forest based. In general, NTFPs are harvested from natural populations, by a high number of small-scale households diversifying their livelihood strategies, with little or no explicit management of the resource base. Overall, NTFPs are not included in forest inventories or resource assessments, resulting in a lack of data needed for management decisions to improve sustainable sourcing and value chain development. Increasingly, however, they are being sourced through innovative production systems that help to ensure product quality and quantity. Two such systems include: 1) forest farming, where species are grown under existing tree canopies and, 2) food forests in urban settings. Innovative certification schemes for wild-harvested products are being recognized as important attributes to improve market awareness and producer incomes. The lack of data presents major challenges for comprehensive estimates of the volumes and values of NTFPs, to the detriment of often marginalized producers across the globe. Innovative research is advancing sustainability throughout the products' value chains and may lead to better incorporation into forest-based bioeconomies.

This session invites scientists from all continents to present research on new and novel approaches to increase sustainable production, sourcing, and equitable benefit sharing in NTFP production networks. Presentations that examine recent and innovative research to integrate NTFPs into broad-scale inventories and assessments are encouraged. Presentations will be selected to portray a diversity of products (e.g., barks, resins, fruits, or honey) and sectors (e.g., pharmacy, food products, or the chemical industry). Participants will share challenges that impede progress to enhance NTFP-related innovation and sustainability efforts and discuss methods for addressing such challenges.

Joana Amaral Paulo[1, 2] , Carsten Smith-Hall[1, 3], James Chamberlain[1, 4], José Guilherme Borges[2, 5], José Antonio Bone[6], Sara Goeking[7]

[1] IUFRO Task Force "Unlocking the Bioeconomy and Non-Timber Forest Products"

[2] Instituto Superior de Agronomia, Centro de estudos florestais

[3] University of Copenhangen

[4] Forest Inventory & Analysis, USDA Forest Service, USA

[5] Coordinator IUFRO 4.04.04 – Sustainable Forest Management Scheduling

[6] Forest Science and Technology Centre of Catalonia, Spain

[7] Assistant Program Manager, Forest Inventory and Analysis, Rocky Mountain Research Station, USDA Forest Service

Innovative technologies for the development of bamboo and rattan products

Bamboo and rattan are two of the most important non-timber forest resources with combined economic, ecological and social benefits. There are 1642 species of bamboos, among which about 100 species are used commercially. There are totally about 32 million hectares of bamboo forest all over the world and the annual production of bamboo is estimated to be more than 30 million tons. Bamboo grows faster than most of the wood species on the planet. It can be harvested in three to four years. Therefore, its growth cycle is much shorter than that of timber. Rattans are in palm family, growing in the tropical and subtropical regions of Asia and Africa. There are approximately 650 species of rattans in 13 genera and a handful of species are widely used. It is estimated rattan is growing in 2900 million hectares natural forests with an annual production of more than 100 thousand tons. Bamboo and rattan have wide applications in many fields. There are more than 10 categories with more than 10,000 bamboo products, including bamboo shoots, bamboo-based panels, bamboo floorings, bamboo daily necessities and bamboo handicrafts, bamboo furniture, bamboo pulping and paper, bamboo fiber textiles, bamboo charcoal and bamboo vinegar, bamboo drinks. They are currently used in construction, decoration, furniture, paper making, packaging, transportation, pharmacy, food, textile, chemical industry and other fields. Compared with bamboo, rattan has relatively narrow applications, mainly for the production of furniture, handicrafts and decorative materials.

This session will focus on the new advancement on the innovative utilization of bamboo and rattan resources. The utilization of bamboo and rattan resources reduces mankind's dependence on timber and causes no sand desertification or soil erosion. It therefore has a critical role to play in protecting forest resources, improving ecological environment and countering climate change. Scientific research on the development of new processing and utilization technology for bamboo and rattan is being conducted increasingly all over the world to ensure the sustainable development of bamboo and rattan resources. The topics of this session will cover bamboo structural timber, bamboo fiber reinforced composites, bamboo structure and properties, bamboo biomass energy, bamboo carbon and vinegar, bamboo preservation and rattan utilization.

Changhua Fang[1] , Jinhe Fu[2]

[1] International Centre for Bamboo and Rattan

[2] International Network for Bamboo and Rattan

Local ecological knowledge of non-wood forest products for sustainable forest management and human well-being in diverse contexts

The session will discuss the bijective relationship between forest and its inhabitants, with emphasis on the changes in such relationship focusing especially on use of non-wood forest products (NWFPs). Forests provide several tangible and intangible benefits for local populations. People use NWFPs for food, medicine, fibre, and employment to sustain their livelihoods as well as various cultural and spiritual values for maintaining cultural identity, and well-being. But those practices are changing over time and space. Changes in patterns of NWFPs use have been associated to multiple drivers including lifestyle changes, urbanization, and lesser contact with nature. Local ecological knowledge plays a double role providing insights on "taking advantage" of forest ecosystem services for sustaining livelihoods, while suggesting practices for sustainable forest management. Global and national policies as well as transnational private sustainability governance initiatives (e.g., FSC) highlight the importance of local ecological knowledge to sustainable forest management and global sustainability in general.

The aim of this session is to present and compare the local ecological knowledge and its dynamics in relation to NWFPs. This session will gather examples of people-forest relationship in different geographical, political and socio-economic context and discuss the relevance of local ecological knowledge (and its transmission) for sustainable forest management.

This technical session will discuss that human- nature interconnections in form of the use of NWFPs, as it has a long tradition in many forested countries and reflects local knowledge and social practices. The current global changes demand thorough analysis of not only local ecological knowledge per se but also how such knowledge is produced, shared and used. This session will debate those changes and factors influencing it.

Nataliya Stryamets[1, 2] , Giulia Mattalia[3], Marine Elbakidze[1]

[1] School for Forest Management, Faculty of Forest Sciences, Swedish University of Agricultural Sciences, Sweden

[2] Nature reserve "Roztochya", Ivano-Frankove, Ukraine

[3] Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice, Italy

Mixed forest plantations as natured-based solutions for climate change mitigation and adaptation

Forest plantations globally provide an increasingly large share of the wood products that contribute to a carbon-neutral bioeconomy, while reducing the harvest pressure on native and natural forests. Their importance is likely to increase with the projected rise in the global demand for the provision of multiple forest goods, and the increasing threat to natural forests posed by climate change. Yet, plantations are faced with controversies related to the potential negative impacts of dominating monospecific plantations for the maintenance of biodiversity and ecosystem functions and to the increasing vulnerability of monocultures to biotic and abiotic risks intensified by climate change (CC).

A growing body of evidence suggests that multi-specific mixed forest plantations provide a wider array of ecosystem services and can be more efficient in sequestrating carbon, while better coping with CC-related stress and biotic disturbances. These results can be traced to mechanisms of complementary or facilitated resource use and alleviated competition in mixed plantations, and can result from a "portfolio effect" of diversification that minimizes the risk of a given species or forest function to be drastically affected.

Nevertheless, there is an apparent reluctance among landowners and stakeholders to adopt mixed plantations as a nature-based solution for CC mitigation and adaptation. Among the possible factors preventing the expansion of mixed plantations is an insufficient scientific base for management practices regarding the type of species mixtures that optimize CC mitigation, adaptation and ecosystem functioning across contrasting site conditions.

This session presents recent research that 1) improves the mechanistic understanding behind the potential of mixed-forest plantations to mitigate and adapt to climate change, or 2) identifies trade-offs and synergies among adaptation, mitigation and other objectives in the management of mixed-forest plantations.

This session focuses on findings from tree diversity experiments, silvicultural trials comparing mixtures with monocultures at different temporal and spatial scales, and analyses of the socio-economic contexts of tree-species diverse plantations.

The final aim of this session is to identify the knowledge gaps that prevent progress towards a wider implementation of mixed plantations in adaptive forest management strategies and restoration measures, and to discuss research approaches to fill these gaps.

Hernán Serrano-León[1] , Ramona Werner[2], Joel Jensen[3], Hervé Jactel[4], Carolyn Glynn[3]

[1] Chair of Silviculture, Freiburg University, Germany

[2] BOKU, Austria

[3] SLU, Sweden

[4] INRAE, France

Non-timber forest products and the bioeconomy

This session provides a forum to share diverse perspectives of the myriad contributions of non-wood products to forest-based bioeconomies. Speakers examine the many roles of NTFPs in bioeconomies, with examples ranging from household to global scales. Presentations cover issues from value chain developments focused on primary producers to global policy actions that support nation's efforts to transition to bioeconomies.

The concept of a bioeconomy was conceived to move away from fossil fuels, promoting more efficient use of renewable natural resource, particularly trees and associated wood products. The vision for a bioeconomy was originally to use of biotechnology for economic growth and creation of jobs. It was to add value by applying biotechnology and commercialization of research and technology. But, as the IUFRO Task Force "*Unlocking the bioeconomy and nontimber forest products*" revealed, there is more to a forest-based bioeconomy. Non-timber forest products are directly consumed by billions of people worldwide and contribute significantly to economies at all levels of society. They were neglected by the initial vision of a bioeconomy.

A bio-ecology vision (Bugge et al. 2016) for bioeconomies is an alternative that provides 'space' for forest products other than wood. The aim of such a vision is sustainability, biodiversity conservation, and avoidance of ecosystem degradation. Creation of value is more through integrated production systems and high-quality geographically branded, certified sustainably sourced products that support sustainable and equitable rural economic development. Agro-ecological practices that reduce risk and encourage ethical and equitable standards across disciplines are fully considered. The principal contributions to human development depend on sustainable production and conservation of biodiversity.

This session provides insights to support a bio-ecological vision for bioeconomies. It is organized around three major themes that coalesced through the Task Force activities. First, assessments of diverse approaches to integrating NTFPs into bioeconomic strategies. Second, activities that support and define transition pathways. Third, tools and technologies to help in the transition, including silviculture and forest management with appropriate technologies for sustainable sourcing of NTFPs. The series of flash talks provide synopses of knowledge gained about the products and their contributions to a bio-ecology vision of bioeconomies. Participants will be exposed to a variety of concise talks from subject matter experts who are considering the nuances of integrating NTFPs into bioeconomies. They will present evidence that supports expanding the definition of a bioeconomy to include all forest products.

Mariana Melnykovych[1, 2, 3] , Carsten Smith-Hall[2, 4, 5], James Chamberlain[2, 4, 6], Sven Mutke[7], Vitor Afonso Hoeflich[8], Liu Jinlong[9], Verónica Loewe-Muñoz[10], Mi Sun Park[11], Harald Vacik[12], Sen Wang[13], Davide Pettenella[14]

[1] IUFRO Working Group 4.05.05

[2] IUFRO Task Force "Unlocking the Bioeconomy and Nontimber Forest Products

[3] Bern University of Applied Sciences, Germany

[4] IUFRO Research Group 5.11

[5] University of Copenhagen, Denmark

[6] USDA Forest Service, USA

[7] Forest Research Centre INIA-CIFOR, Spain, Coordinator RG 1.08

[8] Federal University of Parana, Brazil, Coordinator WG 4.05.03; Deputy Coordinator WG 9.05.08

[9] Renmin University of China, China, Coordinator WG 9.03.05

[10] Chilean Forestry Institute (INFOR), Chile, Deputy Coordinator WG 1.08.00 and 1.01.13

[11] Seoul National University, Republic of Korea, Coordinator WP9.03.04, Deputy Coordinator WP 9.01.07

[12] University of Natural Resources and Life Sciences – Institute of Silviculture, Austria, Deputy Coordinator 4.03.03

[13] University of Toronto, Canada, Deputy Coordinator 9.04.00

[14] Pettenella, University of Padova, Italy, Deputy Coordinator 4.05.02

Novel treatments for wood and biobased products

The concept of wood modification has become an important tool in the methodology of wood protection. Yet the method has so much more to offer, since it can be applied to many biobased materials. In recent years, modification technologies have offered alternative methods to traditional preservation techniques, becoming recongised commercialised methods for solid wood and some wood-fibre products. The aim of this session is to outline the latest activities in modification methods, and how they can help overcome issues such as durability, dimensional stability, fire performance and health and safety in our modern built environment.

As such, the session will comprise activities in the areas listed above, as well as well as outlining how modification methods have been applied in new construction techniques, ensuring long-term performance. It will also cover aspects linked to performance such as life cycle assessments.

Dennis Jones[1] , Lina Nunes[2]

[1] LTU, Wood Science and Engineering, Skellefteå, Sweden

[2] LNEC, Structures Department, Lisbon, Portugal

Pathways towards sustainable and circular forest-based bioeconomies: Advances in research to address challenges and realize opportunities

Bioeconomy has gained much attention as a global goal expressed in different national and international strategies, as a pathway to achieve the UN 2030 Agenda, its sustainable development goals and the Paris Agreement. Although bioeconomy is associated often with a range of benefits, the transition implies trade-offs as well as risks and opportunities. Whereas trade-offs and synergies between different sustainability objectives are unavoidable, identifying them is important to propose solutions that minimize or maximize impacts. For that, systems that monitor, evaluate and contribute the development of the bioeconomy and its sustainability need to be developed.

Despite the growing interest in forest-based bioeconomy, there is no standard definition and the focus has been mainly on wood products. A forest-based bioeconomy includes more than wood! Timber, non-timber forest products, their value chains and the services they provide are part of the forest-based bioeconomy. These can contribute substantially to rural and urban livelihoods, economic growth, climate change mitigation and biodiversity conservation. Likewise, a recent report from FAO demonstrated that the development of wood construction will require an increase of 35% of planted forests by 2050. These forests will contribute to substituting carbon-intensive materials in the transition towards carbon-neutrality, satisfying increasing demand for forest products and emerging markets.

This collaborative session shares experiences and current trends and discusses the challenges, opportunities and best practices towards sustainable forest-based bioeconomies, highlighting nuances of a forest-based bioeconomy. The evaluation of the impacts in all sustainability dimensions (social, economic, environmental, cultural, governance) and along the complete value chain is a strong focus of the session. Presentations of environmental and social impacts are of particular interest. Participants will examine policy and innovative approaches to support and evaluate sustainable and circular forest-based bioeconomies. Oral presentations and posters from government, industry, international organizations, and academia will portray case studies across the world.

The session addresses the following topics:

1. Concepts and goals of forest-based bioeconomies along global value chains.
2. Approaches to assess sustainability in forest-based bioeconomies.
3. Assessment of the forest-based bioeconomy contribution to economic growth, climate change mitigation, biodiversity conservation, circular use of biomass.
4. The role of planted forests for a resourceful bioeconomy, to fulfill future needs, and achieve sustainability goals.
5. The role of bioeconomy in achieving inclusive and equitable societies and a fair distribution of benefits in different contexts and practices.
6. Forest bioeconomy policy, framings, narratives and innovation governance.

Dr. Paola Pozo[1] , Dr. James Chamberlain[2, 3], Dr. Joerg Schweinle[1], MSc Alicja Kacprzak[4], Ivana Zivojinovic[5], Helga Pulzl[5], Christophe Orazio[6], Lidija Zadnik-Stirn[7], Richard Bergman[8], Anne Toppinen[9]

[1] Sustainability Assessment Working Group,Thuenen Institut of Forestry, Germany

[2] Forest Service, United States Department of Agriculture (USDA), USA

[3] Task Force “Unlocking the Bioeconomy and Nontimber Forest Products”, WG 5.11.00 – Non-wood forest products, International Union of Forest Research Organizations (IUFRO)

[4] Forestry and Timber Section, UNECE/FAO, United Nations

[5] IUFRO WG 9.05.01 “Bioeconomy Policy”, University of Natural Resources and Life Sciences, Austria

[6] IUFRO Task Force “Resilient Planted Forests Serving Society & Bioeconomy”, European Institute for Planted forests, France

[7] IUFRO WG 4.05.00 “Managerial economics and accounting”, Ljubljana University, Slovenia

[8] IUFRO WG 5.12.00 “Sustainable utilization of forest products”, USDA Forest Service, USA

[9] IUFRO WG 5.10.00 “Forest Products Marketing and Business Management”, University of Helsinki, Finland

Perception – Awareness – Choice. How forest bioeconomy becomes a reality

Finding sustainable alternatives to fossil materials and products is essential in combating climate change as well as other major environmental challenges such as deforestation and water availability. Renewable wood-based products have an extraordinary potential to both tackle those challenges and achieve Sustainable Development Goals. However, reaching such a potential crucially depends on the perceptions, awareness, and preferences of both producers and end-users. For instance, it depends on the textile industry largely substituting synthetic fibers for wood-based textile fibers. In this context, Bioeconomy has emerged as a concept to approach challenges related to humans' behavior such as over consumption or overreliance on non-renewable natural resources. In this sense, forests and the forest sector are important components of a bioeconomy. Thus, producers' following the value chain and end-users' perceptions and awareness about wood-based products, and ultimately their willingness to buy and use such products play a key role in the transition from fossil-based linear economy towards sustainable circular bioeconomy.

This session focuses holistically on the various aspects of perceptions, awareness, and choices related to forest bioeconomy. Various stakeholder groups (including consumers, businesses, and policy-makers) and their viewpoints will be discussed. Therefore, contributions are invited to explore:

1. *Methods of assessing* perceptions: innovative and well-established methods of participatory approaches, co-creation workshops, communities of practice, service design thinking, and survey approaches are welcome to present results reflecting the perception of various stakeholder groups towards forest-based bioeconomy approaches and concepts. Results, methods and geographic difference are invited.
2. Awareness *raising and supporting mechanisms*: good practice examples and methods of raising awareness and triggering action through e.g. education, social media and other channels, societal initiatives, certification and labeling frameworks, KPIs and reporting frameworks.
3. *Supporting sustainable* choice: good examples of sustainable business ideas/models, products, services, social innovation, green public procurement, land use and city planning; including
    - drivers, agents and barriers to forest-based innovation and market breakthroughs;
    - societal change: from willingness and good examples to mainstreaming sustainable choices.

Diana Tuomasjukka[1] , Camilla Widmark[2], Venla Wallius[3], Adan L. Martinez Cruz[4]

[1] Bioeconomy Programme, European Forest Institute, Finland

[2] Department of Forest Economics, Swedish University of Agricultural Sciences (SLU), Sweden

[3] Junior researcher at the European Forest Institute, Finland

[4] Senior Lecturer at the Department of Forest Economics, Swedish University of Agricultural Sciences (SLU), Sweden

Planted Forests for Achieving a Sustainable Planet

Drawing from the Millennium Ecosystem Services, planted forests have been increasingly important for *provisioning* services of wood fiber and commodity production, and have emerged as a unique *regulating* Nature-based solution (NBS) for climate change adaptation and mitigation. Forest plantations account now for at least 30% of global industrial roundwood production and their contribution can be further increased, while reducing pressures on natural forests. Planted forests have been proposed as one of the most efficient and cost-effective means to store more atmospheric carbon and reduce adverse impacts of climate change in the short- to medium-term, along with improved forest management and reduced emissions from forest area loss.

Increasing the amount and productivity of planted forests is a crucial method to meet increasing timber and climate demands by capturing carbon in forests and subsequent wood products and providing short-run terrestrial energy. They also can help adapt to forest species migration by purposeful introduction of forest species adapted to new climate in a warmer planet, and provide additional forest biodiversity, soil health, and water quality and quantity benefits.

Increases in planted forests to achieve their promise for economic provisioning and climate regulating services mandate that a host of technical, research, policy issues must be resolved quickly. These include technical questions such as (1) the trends and magnitude of planted forests extent needed to increase production and climate roles; (2) the relative benefits of plantations versus natural forest restoration or retention for carbon storage; (3) questions of where such plantings can occur and how to deploy well-performing species to new regions; (4) the technical capacity required to produce seedlings; (5) the rapid development of forest products research and development of engineered forest and mass timber products, and (6) the environmental benefits and impacts of planted forests.

Massive expansion of planted forests must also resolve issues such as (7) rural land tenure status and rights in developed and developing countries, (8) regulations promoting or limiting intensive public forest land management, (9) infrastructure requirements and development; (10) cooperation, partnerships, and policy implementation, (11) investment opportunities, costs, returns, and incentives required to attract private landowners and outgrowers to plant forests, and (12) the effects on local and global timber markets.

These substantial questions must be resolved, or planted or other forests will not achieve their potential to produce desirable wood fiber and products supplies, realize bioenergy opportunities, or store and offset vast amounts of global carbon emissions.

Jacek Siry[1] , Rafal Chudy[2], Virginia Morales Olmos[3], Fred Cubbage[4]

[1] Warnell School of Forestry and Natural Resources, University of Georgia, United States

[2] Forest Business Analytics, Poland

[3] University Center of the Northeast (CENUR), University of the Republic, Uruguay

[4] Department of Forestry and Environmental Resources, North Carolina State University, United States

Scaling up investments and finance towards a responsible forest bioeconomy

To counter climate change, biodiversity loss, and persistent poverty and inequality, we need to manage our land and forest resources better and transition towards more inclusive and sustainable forest management and value chains. To accelerate these changes, increased levels of finance and investment are urgently needed. According to one estimate[1], total financing for forests needs to increase threefold by 2030 and fourfold by 2050 for the world to meet climate, biodiversity and land degradation neutrality targets with the estimated required finance for forest establishment and management alone amounting to USD 203 billion per year by 2050. To achieve this increase in funding, all sources of funding – domestic government, private, and official development assistance – will need to be mobilized within the framework of a forest bioeconomy model. Furthermore, in order to transition to a more sustainable future, the funding will need to support young people to develop innovative ways of implementing change.

This session will share state-of-the-art developments in research and practice about mobilizing finance and investments for inclusive and sustainable forest management and value chains. It will include presentations and discussions on the following areas:

- Climate finance and inclusive and responsible forest investments
- Success cases and lessons learned about the mobilization of finance for indigenous people, local communities and small-scale forest producers
- Innovations in finance: digital tools, databases, match-making platforms, and other decision support tools
- Evolution of investors' preferences and priorities for forest investments
- Factors affecting the attractiveness and "bankability" of investments in forest-based value chains
- The role of youth as innovators and implementers of sustainable bioeconomy models
- Investing in the sustainable and circular bioeconomy with forest and forest products: the role of the private sector.

[1] UNEP. 2021. State of finance for nature: Tripling investments in nature-based solutions by 2030. https://www.unep.org/resources/state-finance-nature

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Marco Boscolo[1] , Jhony Zapata Andia[1], Lyndall Bull[1], Davide Pettenella[2], Mauro Masiero[2], Alex Pra[3], Magdalena Jovanovic[4]

[1] Forestry Division, Food and Agriculture Organization of the United Nations (FAO)

[2] The Department Land, Environment, Agricultural and Forestry (Dipartimento Territorio e Sistemi Agro-forestali - TESAF), Padova University, Italy

[3] ETIFOR SRL, Padova University spin-off, Italy

[4] International Forestry Students' Association (IFSA)

Silviculture for food and medicine in a forest-based bioeconomy

Forests provide numerous ecosystem services and products, including thousands of non-timber forest products (NTFPs) that are essential raw materials for pharmaceuticals, local medicines, cosmetics, and food. NTFPs support health and local livelihoods, contributing to employment, socio-economic development, and increasing the competitiveness of rural economies while also satisfying many peoples' cultural, educational, and spiritual needs. Opportunities to unlock the full potential of NTFPs need the deployment of new knowledge and tools to optimise their sustainable production and management. Thus, in this session, scientists around the world are encouraged to contribute to unlocking silvicultural knowledge supporting the development of models, methods, processes, and decision support tools that address the inventory, planning, harvesting, governance, trade, and conservation of NTFPs as part of the bioeconomy. The session is organised jointly by IUFRO RG 1.08, RG 5.11, and the IUFRO Task Force on Unlocking the Bioeconomy and Non-Timber Forest Products. In this session, speakers will explore the concepts and principles of sustainable forest management in relation to NTFPs and the bioeconomy. Such technical knowledge constitutes an essential tool to facilitate the transition to a forest-based bioeconomy.

Carsten Smith-Hall[1] , Sven Mutke[2], James Chamberlai[3]

[1] Department of Food and Resource Economics (IFRO), University of Copenhagen, Denmark

[2] Forest Science Institute (ICIFOR-CSIC), Spanish National Research Council (CSIC), Spain

[3] Southern Research Station, Forest Service (USDA-FS), USA

Silviculture for the Bioeconomy and Ecosystem Services in Castanea Forests

Chestnut (Castanea) is a widely distributed genus within the Fagaceae family with thirteen species distributed throughout Europe, Asia, and North America and has been naturalized in South America and Australia to benefit local rural economies. The versatility and utilization of chestnut is significant for timber and non-timber goods and ecological services such as: edible nuts, mast for wildlife and game species, fuelwood, sawtimber, soil stabilization, wildfire risk reduction, and rot-resistant wood products. Emerging markets include biocompounds, bioenergy, and carbon credits.

The bioeconomy is an economic model that is being promoted to address climate change, biodiversity loss and poverty alleviation. Although conceived to improve the efficient use of wood to reduce fossil-fuel use, a progressive bioeconomy includes all forest products, including edible nuts. To realize this, silvicultural treatments are needed that encourage production of non-timber forest products. Goals and objectives of silvicultural prescription must explicitly integrate forest products other than just wood; achieving this will require new and innovative approaches to forest management.

There are complex challenges to sustain and restore chestnut forests due to the historical management regimes related to cultivation-abandonment and disease and pest pressures. Knowledge gaps exist in understanding sustainable and practical silvicultural methods to manage chestnut forests using natural regeneration or planting improved sources in novel forest conditions. Challenges from global climate change, changes in disturbance regimes, fluctuations in economic markets, and threats from non-native pests and pathogens affect all chestnut species to varying degrees. The incorporation of traditional ecological knowledge into management systems has been largely absent and would benefit underserved communities while increasing cultural benefits to all of society.

The goal of this technical session is to facilitate knowledge exchange and promote synergy on the ecology and silviculture of Castanea within a bioeconomy framework. The session will facilitate a better understanding of strategies needed to improve performance and success of restoring or sustaining chestnut forests in pure stands, as a component to enrich mixed stands, or as agroforestry systems while being mindful of cultural and economic ramifications. This session takes a progressive approach to compile and improve upon existing knowledge on the silviculture, management, and ecology of chestnut by focusing on multi-species across multi-continental scales. We will provide multiple platforms for participcation including oral presentations, posters, flash talks, and an audience question period for all presenters.

Stacy Clark[1] , James Chamberlain[1], Verónica Loewe-Muñoz[2], Enrico Marcolin[3], Maria Patrício[4]

[1] USDA Forest Service

[2] Instituto Forestal – INFOR

[3] University of Padova

[4] Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança

SMART (Sustainable Modern Acceptable Resilient Technological) Agroforestry Practices for Sustainable Livelihood and healthy environment

Agroforestry is a land use option that integrates tree species, agricultural crops, medicinal and aromatic plants, animals in a given space and time. Agroforestry practices are increasingly gaining momentum throughout the world and particularly in localities where forests are either receding or degraded, showing its limitation for human and livestock use. It is contributing directly to the landscape restoration and environmental amelioration or in other words trees are investment in ecological infrastructure.

It is desirable to understand the tree-crop interaction mechanisms for obtaining sustained yield from tree and agriculture crops, over the long term, under the particular site characteristics and specific location. The choice of tree and agriculture crops becomes very important even if we follow traditional agroforestry practices for a given locality and in the same piece of land.

Agroforestry discipline embraces modern concepts in its practices with basket of options for livelihood and healthy environment, such as payment for ecosystem services, carbon sequestration, recycling of nutrients, etc. It is a must to select tree species, which provide enhanced ecosystem services including changing climate mitigation and meeting local requirements. It is essential to identify tree species that are resilient to climate change, conserve biodiversity/soil /water without hindering the existing eco-system and crop productivity. Tree species and suitable crop combinations are being evaluated in all the part of the globe and required innovative information is required to be shared for sustaining livelihood and maintaining health of agro-ecosystem.

The economic scale of agroforestry products is important, small-scale production may be sufficient for household consumption, but for commercialization, the magnitude of agroforestry production is very important. Agroforestry is picking up as a profitable business to meet the industrial/domestic timber and other non-timber requirements. It is providing rural employment options right from the nursery, plantation management, logging, processing/value addition and marketing of finished products.

Agroforestry is at the central stage because of its multiple advantages and exploiting vertical horizon instead of horizontal expansion. This session aims for scientific papers on design and management principles, perceptive technologies and local innovations from researchers, academicians and practitioners, through oral/ poster mode and to end with an open discussion on these practical aspects of agroforestry to realize it's full potential to for ensuing global challenges.

Sanjeev Chauhan[1] , Swoyambhu Amatya[2], Sheila Ward[3]

[1] Dr. Sanjeev K. Chauhan, Director of Research, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan -173 230, (HP), India,
dres@yspuniversity.ac.in Dep. Coordinator IUFRO 1.04.00

[2] Dr. Swoyambhu Man Amatya, Coordinator, IUFRO Agroforestry Unit (1.04.00), and Member of IUFRO's Task Force "Unlocking the Bio-economy and Non-Timber Forest Products" Nepal, Swoyambhu_amatya@yahoo.com

[3] Ms Sheila Ward, Coordinator, International Society of Tropical Forester, Puerto Rico, tropicalforesters@gmail.com. Coordinator IUFRO 4.02.01, Dep. Coordinator: 1.02.04

Strategies and challenges for improving commercial forest plantations productivity and sustainability in North and South America

Intensive management of forest plantations has evolved significantly in recent decades because of significant advances in understanding of environmental and silvicultural effects on forest productivity, integrated with improvements in information technologies. These intensively managed forest plantations increasingly incorporate large-scale precision silviculture to estimate silvicultural, biotic, and abiotic effects on site-specific forest productivity. Remote sensing technologies combined with strategically located ground-based information provide spatial modeling tools needed for this type of silviculture to expand. Long-term field experiments provide a mechanistic understanding of environmental and silvicultural effects on forest production that is required for the models driving silvicultural decisions.

This long history of intensive silviculture development and improvement is significantly based on the scientific and technical development generated by the Forest Productivity Cooperative (FPC), which have been creating innovative solutions to enhance forest productivity and value through the sustainable management of site resources over the last 50+ years. This industry-government-university partnership has generated seminal research with extensive implications for increasing productivity and sustainability in the North and South America.

The main focus of this session is to explore new methods and technologies, from remote sensing to stable isotopes, to manage site resources more precisely and accurately at multiple spatial scales. Using these tools and methods, we intent to usher new solutions to the issues faced by the forest products industry, today and in the future, and find innovative ways to sustainably increase productivity in intensively managed plantations in the North and South America.

Otávio Campoe[1, 2, 3] , Rachel Cook[2, 3], Rafael Rubilar[2, 3, 4], David Carter[3, 5], Tim Albaugh[5, 6]

[1] Dept. of Forest Sciences, Federal University of Lavras (UFLA), Brazil

[2] Dept. of Forestry and Environmental Resources, North Carolina State University (NCSU), USA

[3] Co-director of the Forest Productivity Cooperative (FPC), USA

[4] Dept. de Silvicultura, Universidad de Concepción (UdeC), Chile

[5] Dept. of Forest Resources and Environmental Conservation, Virginia Tech (VT), USA

[6] Forest Productivity Cooperative (FPC), USA

Strengthening Teak Forest Management for Sustainable Teakwood Supply Chains and Trade

The exceptional quality of teak timber (*Tectona grandis* L.f.), its high value in the global timber market, the available superior quality planting stock and the standardized protocols for establishing teak plantations, have made teak one of the most important species for planting across 70 tropical countries. Teak plantations according to various estimates cover between 4.4 to 6.9 million ha and the global trade of teak roundwood as per the recent ITTO report is around 1.02 million cu.m per year on average and the demand is predicted to rise in the coming years. Considering the declining supply from natural teak forests, the long-term prospects for plantation-grown teak appear promising. However, much controversy has arisen in several countries by the promotion of teak plantation investments based on unrealistic yield projections and pricing scenarios giving opportunities to exaggerate rates of return on investments. Besides, there exists no common international log grading rules in most exporting countries and the measuring units and volume of log dimensions are different that further complicate the situation. The quality of teakwood originating from intensively managed planted teak forests has improved where superior planting material and good management practices are applied. One increasingly important consideration influencing the trade of plantation-grown teak is forest management certification and legality issues; the legal source and supply chain control need to be strictly enforced. Establishing transparent and traceable timber supply chains will provide teak growers more opportunities to participate in global markets. In many tropical countries smallholders and farmers own planted teak forests. Innovative simplified certification systems need to be applied for smallholders' who are unable to bear the high transaction costs involved in the existing certification system. In addition, teak plantations have high potential in sequestering carbon and contribute to Forest Landscape Restoration, in particular on degraded lands. The session will examine the current international situation with respect to the supply of quality plantation teakwood from sustainable sources.

Major objectives are:

- Strategies for improving the productivity of teak plantations owned by commercial entities and smallholders, while conserving the existing teak genetic resources in natural forests.
- Expansion of teak trade from legally harvested and sustainably managed sources.
- Options to establish international log grading rules based on a uniform definition of log dimensions and measuring units
- Develop R & D innovation in processing technologies and design for quality teak products from short rotation plantations.
- Opportunities and challenges of smallholder's teak production systems.

Gilles Chaix[1], Mario Tomazello[2], PK Thulasidas[3], S. Sandeep[4], Tetra Yanuariadi[5]

[1] Coordinator, IUFRO WP5.06.02, CIRAD, AGAP Institut – Equipe PHIV, TA A108/02 – Avenue Agropolis, 34398 Montpellier Cedex 9, France

[2] Deputy Coordinator, IUFRO WP5.06.02, Universidade de Sao Paulo, Escola Superior de Agricultura Luiz de Queiroz, Departamento de Ciencias Florestais, Sao Paulo, Brazil

[3] Deputy Coordinator, IUFRO WP5.06.02), TEAKNET- India, Kerala Forest Research Institute, Peechi - 680 653, Kerala, India

[4] TEAKNET, Kerala Forest Research Institute, Peechi – 680 653, Kerala, India

[5] Forest Industry Division, International Tropical Timber Organisation, Yokohama, Japan

Sustainable Forest Operations (SFO): Challenges and opportunities towards a resilient wood supply chain

In 2018 the IUFRO Task Force on Climate Change and Forest Health provided an opportunity for forest operations scientists around the globe to examine the concepts and approaches of sustainable forest operations (SFO) as a key element for reaching the goal of sustainable forest management. The innovation behind this new paradigm of SFO is the integrated approach to forest operations, aiming at reconciling the bio-economy, environmental ecology, human factors and society at different scales.

In this context, it is important to underline that SFO is not an "absolute" concept, rather an organic one. Different solutions may be adopted for maximizing the sustainability of forest operations depending on socio-economic, -political and environmental conditions within their geographic context. The SFO concept underlies a complex system that implores policy making entities to help protect the future of forests, the environment, and their complex ecosystems, without compromising the use of forest products or the profitability of forest operations.

The aim of this session is to analyse how forest operations may impact achieving the UN Sustainable Development Goals (SDGs) and targets. Even though, SFO can be seen within all SDGs, in this context SFO is strictly related with the SDG 15 "Life on Land", with direct implications on SDG 8 "Decent Work and Economic Growth", SDG 12 "Responsible Consumption and Production" and SDG 13 "Climate Action".

Direct and indirect, positive and adverse effects on these SDGs due to actual strategies developed aiming at SFO will be analyzed; related solutions to maximize benefits and to minimize impacts will be identified and discussed.

Each discussion panel will be responsible for analysing the interactions between forest operations and the identified SDGs in their respective regions. Further, each panel is expected to propose solutions for moving towards SFO on the basis of the five performance areas identified as the main pillars behind this concept (i.e. Environment, Economics, Ergonomics, People & Society and Quality Optimization), and how they can contribute to SDGs # 15, 8, 12 & 13. Contributions about forest operations and wood supply chain will be welcome, in particular those showing a strong link within two or more SDGs; the scale of the study is not important, but the replicability of approaches and solutions must be evident. The real challenge is to find a balance among the performance areas, addressing each of them without negatively affecting the others.

Enrico Marchi[1] , Dalia Abbas[2], Andrea Laschi[3], Zimbili Sibiya[4]

[1] Italian Society of Silviculture and Forest Ecology / Department of agriculture, food, environment and forestry, University of Florence

[2] National Science Foundation, USA

[3] Department of Agricultural, Food and Forest Sciences, University of Palermo

[4] Department of Forest and Wood Science, Stellenbosch University

The role of ergonomics and worker safety in sustainable forest operation

The prevention of risks related to health and safety in forest operations remains a significant challenge worldwide. In the last decade, the concept of sustainability in forest operations has come to include social sustainability aspects such as working conditions and workers' health and safety. It is still possible to improve manual, motor-manual, and mechanized working conditions to reduce accident risks and to prevent work-related diseases. Although general knowledge about good work organization, safety education, training, and health management is a high priority in forest enterprises, it is still not implemented enough in forestry practice to reach the desired effect. This session will explore the subject-sharing experiences on improving safety consciousness, a safe work environment, and the role of forest ergonomics. Presenters are invited to discuss the subject of prevention of risks regarding health and related to technological advancements and innovations that address these themes.

Elena Marra[1] , Francesco Neri[1], Cristian Hook[2], Sibiya Bonisiwe Zimbili[3]

[1] Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, Italy

[2] Department of Forest Ecology and Management (SLU), University of Umea, Sweden

[3] Department of Forest and Wood Science, University of Stellenbosch, South Africa

Traditional knowledge, geographical indications and non-timber forest products towards a bioeconomy in community-based agroforestry systems

Non-timber forest products (NTFPs) have gained salience as measures for resilience to climate changes and to empower traditional and local communities as alternative livelihood in a volatile and rapidly changing world, illuminating pathways to bio-economies at local, regional and national scales. Exemplary examples are found from coastal tropical mangrove forests to high mountainous ecosystems where some of the most valuable NTFPs enter bio-based economies served by market and non-market value chains that increasingly are global in nature. More than 2 billion people worldwide consume directly NTFPs foraged from forests. Wild foods are the foundation of the nutrition and food security for a third of the world's populations. NTFPs are frequently vital income sources for forest communities, contributing much to household and local livelihoods. For forest-based economies, NTFPs contribute much, and provide tremendous potential for progressive and comprehensive bioeconomies.

Traditional knowledge (TK) including indigenous and local knowledge (ILK) is foundational to sustainable sourcing of forest products and services other than timbers. For many cultures these plants, fungi and animals are not considered products, and have greater non-market values. TK supports social, economic and ecological sustainability the resources that provide NTFPs. Sustainable forest-based bioeconomies compliment this with science-based knowledge for sustainable management and provision of services and products for the greatest benefit. This session focuses on recent research that provides insights into key elements that support successful transition to a forest-based bioeconomy, with concrete examples of NTFPs. The role of TK lays the foundation for this session, which also examines governance, value chain development, policy and regulations, and production systems. Both products (GIs for example) and area level registration (heritage systems) are reviewed potential mechanism to enhance NTFPs.

Progressive and novel research reveals that there are a variety of approaches and experiences in pursuing forest-based bioeconomies. Key elements of successful transition pathways include recognizing and respecting the value of traditional indigenous knowledge, involving stakeholders from primary producers to final consumers to improve benefit-sharing, developing infrastructure along the entire value chain, particularly at the source, collaboration of private and public entities to ensure sustainable sourcing of the products, and producing consistent quantity and high-quality products. The tremendous diversity of factors that influence NTFP production and consumption in community-based agroforestry requires research and development in a broad range of disciplines -- social dimension, markets and marketing, production systems, and policy. This session examines research that focuses on factors beyond the conventional bioeconomy concepts.

Mi Sun Park[1, 2] , Ryo Kohsaka[3], James Chamberlain[4]

[1] Seoul National University

[2] IUFRO WG 9.03.04 (Traditional Forest Knowledge)

[3] The University of Tokyo

[4] Research Forest Products Technologist, USDA Forest Service, 1710 Research Center Drive, Blacksburg, VA, 24060 USA

Transitioning to a Bioeconomy with Non-Timber Forest Products: Leadership from Latin America and the Caribbean

Forests have a significant role in the bioeconomy, contributing to households' food security, health and nutrition, energy independence, jobs and climate change mitigation. More and more countries are working to transition from a business-as-usual economic model to a progressive bioeconomy that will affect how forests are managed. More than one-third of all nations have bioeconomy strategies that chart a transition away from fossil fuels and toward improving wood use. Although, the concept originated in Europe with leadership from the European Union, other regions are demonstrating extraordinary leadership in this transition. In fact, some Latin American and Caribbean countries have bioeconomy strategies and national legislation that support and promote this progressive model. Brazil has had policies to support non-timber forest products since 2009 and, as of 2019, integrated the concept of bioeconomy of sociobiodiversity into national policies. Likewise, the bioeconomy policies of Argentina explicitly acknowledge the major economic importance of non-timber forest products (NTFP) at the national and local levels.

According to the UNDP, Latin America and the Caribbean (LAC) are biodiversity giants and have great potential to contribute to global bioeconomies. It is noteworthy that the region encompasses the Amazon Forest which is present in nine countries in Latin America and the Caribbean. In the Amazon, a bioeconomy based on forest products, timber and non-timber, has been discussed within the scope of public policies, in view of its high economic potential, capabilities of transforming the reality of the local population through possibilities of equitable sharing of benefits. In fact, the bioeconomy leverages innovations in science and bioindustries to achieve sustainable ecological and social growth and employment based on rich biological resources.

The region has great potential to provide opportunities to develop a forest-based bioeconomy. Many products from the regions' forests already contribute to a bioeconomy. The unprecedented traditional knowledge associated with forest biodiversity, which is elemental to the culture and heritage of indigenous people and traditional communities are valuable assets and contribute much to bioeconomy strategies.

This subplenary session will highlight the important contributions of NTFPs to Latin American and Caribbean bioeconomy. The selected panelists will be exemplary for their leadership on this bioeconomy and NTFP. They will examine efforts within their respective countries to lead a transition to bioeconomy and address regional cooperative actions. Their perspectives will elucidate the challenges with such efforts and will pontificate on opportunities that LAC nations are realizing to advance the transition to bioeconomies.

Sandra Afonso[1] , Verónica Loewe-Muñoz[2], James Chamberlain[3], Vitor Afonso Hoeflich[4]

[1] Brazilian Forest Service

[2] Chilean Forestry Institute (INFOR)

[3] USDA Forest Service

[4] Federal University of Parana, Brazil

Tropical Peatland Forest Conservation and Sustainability: Challenges and Opportunities

This session aims to provide scientific and science policy linkages on tropical peatland conservation and sustainability to tackle climate change using adaptation and mitigation strategies. More specifically, this session will present recent results on: (1) mapping and modeling tools for tropical peatlands for long-term monitoring; (2) land use and land cover changes as one of the major drivers of degradation of peatlands; (3) inventories of carbon stocks and dynamics of greenhouse gas emissions arising from peatlands; (4) socio-economic and governance facets of peatlands for effective conservation and restoration; and (5) climate change adaptive and mitigation strategies, and potential actions for their inclusion in national and international commitments; and (6) scientific knowledge and policy-making linkages. We expect to engage scientists, early career professionals, students, practitioners and policy makers, that can show up cases of studies and strategies to advance the knowledge, conservation and sustainability of these ecosystems.

Alma Vázquez-Lule[1] , Arimatéa C. Ximenes[1], Kristell Hergoualc'h[1], Erik Lilleskov[2], Daniel Murdiyarso[1], Randy Kolka[2]

[1] Center for International Forestry Research, Indonesia

[2] U.S. Forest Service

Wood durability and wood protection strategies for long-term carbon storage of wood products

This session is in the area of forest products research and partly involves also the forest management/ silvics of forest tree species for production of heartwood of high biological durability (especially in forest plantations). More specifically the session deals with the importance of utilizing wood resoures with adequately high heartwood durability (ie. naturally durable heartwood of particulat tree species such as *Tectona grandis* and certain tropical hardwoods, *Eucalyptus pellita* or *Robinia pseudoacacia*) for contruction indoors or outdoors to withstand biological hazards due to Basidiomycetous fungi, soft rot fungi, termites and wood-boring insects under tropical and temperate terrestrial climates. Also the session will deal with developments of both biocidal and non-biocidal wood treatment/protection strategies to confer long-term biological resistance of relatively less durable wood materials (ie. sapwood species and species with non-durable heartwoods from native or planted forests) as sustainable wood products including construction. Such long-lived harvested wood materials contribute well to ensure long term carbon storage (ie. favouring climate change mitigation) by preventing biological degradation in service or even loss of carbon to the atmosphere due to fire (ie. fire protection for mainly contructed wood). It would be relevant in this session to also discuss research undertaken in the field of forest management of both native and planted wood species that are known to produce biologically durable heartwoods of marketable quantities to sustain the forest industries with such durable renewable materials while satisfying societal demands for such intrinsic wood quality in structural applications (including the emerging mass timber buildings) and furniture. Therefore among the topics of interest here are:

1. Durable hardwood and softwood plantations. Silvicultural management and studying the causes of heartwood durability and associated wood quality, and durability classification research (eg. cell wall lignification, potent heartwood extractives chemistry) of an emerging resource,
2. Wood decay and termite risk management of wooden, including cultural-value, properties. As global warming causes an expansion of biological hazards of wood into once cooler regions, there is urgency to detect incidences of attack and protection of wood in construction using innovative pest control approaches,
3. Development of wood protection systems for long-term carbon storage of a variety of non-durable woods in contruction including mass timber use ("tall buildings"). Studies on the performance of environmentally acceptable wood protection systems based on chemical biocides (and natural products), fire retardants, or non-biocides (ie. wood modification) befitting green building concepts,
4. Global wood durability evaluation and classification research

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Andrew H.H. Wong[1, 2, 3] , Marie-France Thevenon[2, 4, 5], Roger Meder[2, 6, 7], Jun Liu[8, 9], Tripti Singh[2, 10, 11]

[1] International Wood Culture Society, Kuching, Malaysia

[2] International Research Group on Wood Protection, Stockholm, Swedem

[3] Deputy Coordinator, IUFRO Unit 5.03.00 (Wood Protection), Malaysia

[4] Unit for Research in BioWooEB, CIRAD, France

[5] Coordinator, IUFRO Unit 5.03.00 (Wood Protection), France

[6] Forest Industries Research Centre, University of the Sunshine Coast, Australia

[7] Coordinator, IUFRO Unit 5.06.00 (Properties and utilization of plantation wood), Australia

Advances towards more accurate forest biodiversity indicators and monitoring

There is clear evidence that forest biodiversity has been impacted for centuries by human activities in and outside forests across the world. Different systems of reporting at regional or national levels have proposed different sets of indicators of forest biodiversity, often based on already available dendrometric data, rather than on the occurrence and abundance of organisms across multiple taxonomic groups. Recent scientific advances in different disciplines – both within social and natural sciences – may be key in improving these existing indicators and monitoring, or in proposing new indicators. These include: i) developing new biodiversity measurement techniques (DNA metabarcoding, acoustic recordings, image analysis, remote sensing, spectranomics); ii) analysing existing or new indicators through their relationships to the indicandum; iii) evaluating their understanding by different stakeholders , and their social impact; iv) testing and developing monitoring schemes (e.g. of Essential Biodiversity Variables – EBVs), integrating statistical modeling across taxonomic groups, data and indicator types. Indeed, there is increasing evidence to suggest that different taxonomic groups respond in different ways to environmental pressures such as forest management, climate change or invasive species. The session will be based on presentations on biodiversity indicators and monitoring covering multiple taxonomic groups and will consider organizing a panelist discussion at the end of the session on the main points made by the presentations. The aim of the session will be to boost the dialogue between researchers concerned with forest biodiversity monitoring and indicators, and to propose a way towards the improvement of existing indicators and monitoring schemes.

Frédéric Gosselin[1] , Marion Gosselin[1], Francesco Chianucci[2], Sabina Burrascano[3], Anna Barbati[4]

[1] INRAE – UR EFNO - France

[2] CREA- Research Centre Forestry & Wood Arezzo- Italy

[3] Sapienza Università di Roma- Italy

[4] Department for Innovation in Biological, Agro-food and Forest systems DIBAF - University of Tuscia- Italy

Can adaptive genomic drive sustainable forest management under climate change?

Forest areas are important for ecosystem services, as forests are multifunctional, serving economic, social and environmental purposes. Climate change, air pollution, unsustainable forest management, invasive species, urbanization, and habitat loss and fragmentation reduce forest biodiversity, may adversely affect genetic diversity, and put at threat the future adaptive potential and sustainability of forests. In fact, over 60 % of forest habitat types identified by the Habitats Directive are reported to be in 'unfavourable conservation status'. As EEA points out "*genetic variety in regionally adapted forests is essential for adapting to new environmental conditions such as climate change*". According to The State of the World's Forest Genetic Resources (FAO, 2014) roughly half of the forest species are threatened or subject to genetic erosion, making forests less resilient and compromising future adaptability to changing environmental conditions. This might also affect the future supply of wood and other environmental and social services forests provide. Interpreting ecosystems as complex adaptive systems could be useful in understanding the complexity of interactions and how the system adapts to changing conditions. Silvicultural practices could enable accelerated genetic adaptation by helping populations follow the changes taking place that are currently known and preserve genetic resources as a "reservoir" of future options (emergence of new innovative genetic combinations) to respond to unknown changes. A revaluation of forest management planning has become necessary, with a greater focus on biodiversity conservation and preservation of forest ecosystems. Therefore, it is extremely important to provide a sustainable forest management (SFM) approach to local and rural community for a correct sustainable use of forest products, useful for social-economics, but preserving forest ecosystem biodiversity. This session will present forest research advancements in genetics, genomics, and adaptive silviculture presenting actual knowledge on forest genomics and sustainable management strategies which could preserve and/or increase the resilient ability of our forests under Climate Change. For this it is important the interconnection among different disciplines to give wide overview considering forest ecosystem, climate change and forest genetics. This is possible through talks presenting the latest advancement on i) forest management options in polluted forests, ii) innovative silvicultural practices and management and iii) landscape genomics and applied genetics to support Sustainable Forest Management. The multidisciplinary approach permits to identify research gaps furthering dialogues and cross-sector cooperation and promote the multi-functionality of forests and their service. Finally, the session include voluntary poster and panel presentations.

Hojka Kraigher[1] , Yasutomo Hoshika[2], Cristina Vettori[3], Donatella Paffetti[4], Cesare Garosi[5]

[1] Slovenian Forestry Institute (SFI), Slovenia

[2] Italian Society of Silviculture and Forest Ecology (SISEF), Italy

[3] Institute of Bioscience and BioResources (IBBR), National Research Council (CNR), Italy

[4] Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI), University of Florence, Italy

[5] PhD student of Agricultural and Environmental Science, University of Florence, Italy

Disappearing oak woods: conservation and management of global oak forests

Oaks (*Quercus* spp.) are foundational species in many forest ecosystems. There are more than 500 species of oaks worldwide, and they can be naturally found in all continents except Antarctica and Australia. They exist in temperate broadleaved forests, subtropical and tropical montane/submontane forests, and temperate and subtropical arid and scrub forests. Mature oak trees provide direct and indirect support to thousands of species. For example, in the UK, old *Quercus robur* trees are associated with nearly 2300 species of flora and fauna. In addition to high biodiversity values, oaks provide high-quality timber and a wide range of other ecosystem services. Most of the oak species are long-living in their respective ecosystem; hence, they are essential for ecosystem functioning and health. However, oak forests worldwide are declining due to climate change impacts, diseases, habitat destruction, and the replacement of oak trees by fast-growing tree species. The report of oak decline has been emerging in scientific literature since the end of the 20th century. Therefore, there is an urgent global need to sensibilize and work towards the conservation and sustainable use of remaining oak forests. Moreover, we call to BRING BACK THE OAKS in their native ecosystem, where they used to thrive for thousands of years, to increase biodiversity, ecosystem services, and resilience to climate change impacts. Therefore, the planned session invites contributions to oak forests' conservation, restoration, regeneration, and management. The proposed session aims to invite contributions from all different oak forest ecosystems comprising a wide range of topics. We also plan for a special issue from our session.

Somidh Saha[1] , Teresa Fidalgo Fonseca[2], Magnus Löf[3], Daniel C. Dey[4]

[1] Research Group Sylvanus, Institute for Technology Assessment and Systems Analysis (ITAS), Karlsruhe Institute of Technology (KIT), Germany

[2] University of Trás-os-Montes and Alto Douro, Portugal

[3] Swedish University of Agricultural Sciences, Sweden

[4] Northern Research Station, US Forest Service, USA

Ecological and socioeconomic analysis of invasive species in forest ecosystems under changing environmental scenario

Forest ecosystems are a limitless source of provisioning, regulating, supporting and cultural ecosystem services. Complex interactions among flora, fauna, geology, topography and climate make these ecosytems diverse, unique and crucial for survival of life on the planet. Ecological and socio-economic perturbations caused by biotic invasions are a contemporary threat to global forest sustainability. Sufficient evidence is present in the literature stating that invasive alien species are one of the significant drivers of environmental degradability, population decline and species extinctions worldwide. These species can also have significant socioeconomic impacts by directly affecting human health or indirectly affecting ecosystem goods and services. Invasive species become more threatening in the forested ecosystems since these interrupt the integrity of an otherwise intact and self-sufficient ecological structure, and any change at one end of the structure disrupts its entire functional series, causing compelling and sometimes even irreversible impacts. Studies have proved that the vegetation ecology, community composition, litter decomposition and soil nutrient status in forest areas are drastically affected by the spread of invasive species. Majority of the invaders in forest ecosystems are woody perennials, including trees, lianas, and shrubs; however invasion by shade-tolerant herbaceous flora is also witnessed. At the same time, invasion of forest ecosystems by grass species is an under-recognized phenomenon that in combination with other invaders could substantially reduce forests' resistance and resilience to change.

Human mediated transport, migration, and commerce are continuing to disperse an array of invasive alien plant species across diverse forest ranges including the ones which are inaccessible or yet to be explored. Deforestation practices and other sort of anthropogenic disturbances are facilitating survival and establishment of these introduced species. Furthermore, ongoing climate change can directly increase invasion risk in forests as it alters the abiotic and biotic conditions under which the native species establish, survive, reproduce, and spread. Invasive species are often enhanced by warmer temperatures, reduced snow, short winters and increased carbon concentrations. Prolonged duration or high intensity of climate change has the potential to leave long-lived, slow-dispersing native flora vulnerable, while creating more niches for short-lived, fast-dispersing invasive species. Since human welfare is inextricably associated with the ecosystem services provided by forest biodiversity, it is crucial to sustain these reservoirs in the most undisturbed and natural form.

Daizy Rani Batish[1] , Harminder Pal Singh[2], Shibu Jose[3]

[1] Department of Botany, Panjab University Chandigarh, India

[2] Department of Environment Studies, Panjab University Chandigarh, India

[3] School of Natural Resources, University of Missouri, Columbia, MO 65211, USA

Emerging socio-economic dynamics in Wildland-Urban Interface forest landscapes

The impacts of Global Climate Change continue to adversely affect the socio-economic and ecological (socio-ecological hereafter) systems of forested landscapes worldwide. Increasing urbanization and the movement of people and infrastructure into wildlands is also exacerbating these problems. These forested peri-urban or Wildland-urban interface (WUI) areas are changing due to wildfires, drought conditions, and other extreme natural disturbances, and their related impacts. For example, each year wildfires burn millions of hectares of forest and brush lands in the WUI at a significant ecological, social, and economic cost annually. During 2001-2018, wildfires worldwide burned an average of 463 million hectares of forested or vegetated land that have been affected and as a result a significant number of lives, homes, and ecological resources are lost every year. The socio-ecological impacts to forests in the WUI are also increasingly affecting vulnerable and marginalized human communities that were previously less affected relative to more affluent ones. However, the extent to which vulnerable and marginalized communities are actually being impacted by extreme forest wildfire events is not clearly understood, nor is the severity of the impacts. The underrepresentation of vulnerable communities within the literature threatens to exacerbate impacts to these communities by not providing forest managers sufficient information to base management and policy decisions on. Sharing such knowledge, experiences, and scientific information can ultimately be used to better plan, manage, and restore these socio-ecological systems and better maintain the sustainability of ecosystem processes and services from forests. This session will bring together scientists, researchers, forest managers, practitioners, and policy makers to better understand these problems, improve our understanding of emerging socioeconomic and ecological issues in the WUI. Participants will discuss the dimensions of the problem and provide ideas, experiences, and communicate potential solutions to address emerging socio-economic issues for the management, restoration, conservation, design, planning, and sustainability of forests.

The session may fall under two of the Conference Theme 1: Strengthening forest resilience and adaptation to stress (i.e., Forest management for global change adaptation and mitigation) and Conference Theme 4: Forests for sustainable societies (i.e., Forests, trees, and human well-being).

Submitted abstracts should address the following topics: understanding extreme climate change impacts to socio-ecological systems; management and restoration of ecosystem processes and services; how do wildfires and other natural disturbances and disasters impact forested and WUI communities, case studies demonstrating the socio-economic or environmental justice impacts to vulnerable communities, among others.

Jose Sanchez[1] , Francisco Escobedo[1], Matt Sloggy[1]

[1] USDA Forest Service

Extent and ecological consequences of hunting in the forest ecosystems

There are few places left on the planet where the impact on people has not been felt. We have explored and left our footprint on nearly every corner of the globe. As our population and needs grow, we leave less and less room for wildlife. Habitat loss and hunting activities are the main drivers of the loss of functional diversity in forest ecosystems, challenging equilibrium among ecological functions and thus the durability of ecosystem services. Hunting is predicted to exacerbate the degradation of ecological functions such as seed dispersal and forest regeneration quicker than the expected effects of climate change. As wildlife managers seek to address this problem, there is a need to understand the drivers and the extent of the wildlife hunting on forest ecosystem functioning, the status of wildlife populations and significant threats, taking into account local contexts. The aim of this technical session is to call for systematic consideration of hunting effects in (large-scale) biodiversity assessments globally for more representative estimates of human-induced biodiversity loss. As a matter of fact, a few case studies on the impact of hunting on the forest ecosystem functioning worldwide will be presented, enabling participants to understand the impact of the wildlife trade through the prism of functional diversity, the status of wildlife populations and major threats within an overarching conceptual framework; develop an overview of wildlife threats, including its underlying causes and impacts; share experiences and lessons from different regions of the world, and identify emerging best practices and priorities for the future in wildlife conservation and ecosystem health.

CHABI DJAGOUN[1] , Hugues Akpona[2], Adeniyi Charles Adeola[3], Edward D. Wiafe[4], Achille Assogbadjo[1]

[1] University of Abomey-Calavi, Benin

[2] African Park Network, South Africa

[3] Kunming Institute of Zoology, Chinese Academy of Sciences, China

[4] Presbyterian University College, Ghana

Forest biodiversity indicators: supporting our response to the biodiversity and climate emergencies

Research and development of forest biodiversity indicators and their impact to monitor, assess and report sustainable forest management as well as their adaptation towards new and emerging needs are presently high on the political agenda. Political decision makers are calling for better forest biodiversity indicators to support responses to new and emerging needs, such as the climate emergency.

The need for biodiversity indicators to deal with the current biodiversity challenges is a central part of national, regional and global forest biodiversity strategies such as the Convention on Biological Diversity post-2020 global biodiversity framework and the European Union Green Deal. The endeavors to develop appropriate biodiversity indicators and alignment to these and other international instruments such as the UNFCCC Paris Agreement, and the UN Decade on Ecosystem Restoration are major reasons for the renewed interest in forest biodiversity indicators.

Forest biodiversity indicators will be crucial to verify the impact of actions taken with regard to forest biodiversity related targets and goals and the related implementation of measures for the maintenance and enhancement of forest biodiversity within the framework of the Criteria & Indicators for Sustainable Forest Management Processes as well as national, regional and global biodiversity, climate and forest strategies.

However, it is difficult to define the concrete forest biodiversity status and the targets/thresholds/ranges to be aimed for at various levels. The dynamics of forest development and the diversity of forest types make a clear definition of objectives difficult. The application and evaluation of measures to promote biodiversity, and of indicators to monitor the related progress are thus challenging.

Also aligning or developing forest biodiversity indicators to support the investigation of new or emerging issues such as forest resilience is accompanied by a range of technical issues and implementation challenges.

Therefore, the IUFRO Working Party 9.01.05 proposes a session on Forest Biodiversity Indicators. This session will focus on new research undertaken in this area and give the IUFRO science community and associated policy makers and stakeholders the opportunity to share experiences and learnings.

We encourage presentations and poster covering various forest-related biodiversity indicators (e.g. species, structure, genetics, soil biodiversity, ecosystems) at various levels (stand, national, regional, global) and also encourage presentations and poster on new techniques of monitoring the development of forest biodiversity (e.g. remote).

Stefanie Linser[1]

[1] Institute of Forest, Environment and Natural Resource Policy, University of Natural Resources and Life Sciences, Vienna (BOKU)

Forest genomics as a vantage point to biodiversity and adaptation under global change

Genomic approaches in forest research have taken a giant leap in recent years, opening new opportunities for fundamental and applied research. They can give us a deeper understanding of the diversity of ecosystems, species, populations and individuals. Genomic data carries information about the populations´ and species´ evolutionary past and inform us about the role of genetic diversity in forest ecosystems under climate change.

Genomic methods can be used to estimate genetic diversity, its spatial structure, genetic adaptation and maladaptation, as well as effects of forest breeding, management practices and exploitation. Application of these methods offer new possibilities such as identifying populations harboring unique genetic diversity and adaptations to specific environmental conditions.

All this knowledge is critical for tackling the challenges of forest regeneration and restoration, including the selection of appropriate individuals and provenances, planting designs, and species mixtures, under changing global climate on stand and landscape levels and for maintaining biodiversity and forest ecosystem services.

The aim of this session, which addresses Theme 3, is to showcase applications of modern genomic approaches in forest ecology and population genomics with potential to aid forest management and conservation. The session will provide case studies or examples of how genomics can contribute to a better forest and landscape management and illustrate what genomic tools are being used to prepare forests worldwide for facing climate change.

This session will be organized as a two hour session with one invited 30-minute plenary talk, four 15-min talks, chosen from submitted abstracts, and an accompanying poster session. An additional 30 minutes slot is reserved for 1-3 minute lightning talks by selected poster presenters. Lightning talks seek to provide a stage for the work of early career scientists.

Within this session, the best Postdoc and PhD researcher posters will be awarded a prize to encourage and support young forest genomics scientists.

Tanja Pyhäjärvi[1] , Christian Rellstab[2], Katrin Heer[3], Santiago C. Gonzalez-Martinez[4], Juan Pablo Jaramillo-Correa[5], Chedly Kastally[6], Amanda de la Torre[7], Marjana Westergren[8]

[1] Department of Forest Sciences, University of Helsinki, Finland

[2] Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Switzerland

[3] Albert-Ludwigs-University Freiburg

[4] INRAE France

[5] UNAM, Mexico

[6] University of Helsinki

[7] Northern Arizona University

[8] Slovenian Forestry Institute, Slovenia

Forest landscape restoration (FLR) and SDG Goals from the lens of forest policy and governance

United Nations has declared 2021- 2030 as the decade of forest landscape restoration (FLR). Globally, there are over 2 billion hectares of degraded forests that need to be restored (Stanturf, Palik, & Dumroese, 2014). Therefore, forest restoration initiatives have become important and are currently being carried out all over the world to lower the net rate of forest loss (Chazdon, 2008). A restoration's success is measured by how well the ecosystem functions. Successful restoration initiatives must show quantifiable gains in physiochemical and biological characteristics (Palmer et al., 2005). It is crucial to remember that these changes may take decades to manifest in forests, so discussing the overall effectiveness of the restoration should be replaced with an awareness of the trajectory of the ecosystem and progress towards that objective (Palmer et al., 2005). Consequently, for a successful forest landscape restoration a wide range of disciplines are involved, ranging from ecosystems conservation to policy and governance regarding the forest sector at national and global level. Additionally, in many cases of forest landscape restoration programs are dealing with different anthropogenic factors, specially in the tropics. Anthropogenic factors are one of the major drivers of forest degradation and deforestation in most part of the world. Hence, for successful FLR community engagement has been adopted. In one hand FLR is very important in the forest sector and on the other hand Sustainable Development Goal (SDG) is also another globally significant target along with the climate change issue. In many cases FLR and SDG have synergy but there might be other cases where FLR may have conflict with countries SDG oriented policy program. As it is quite obvious there FLR and SDG have wide range of stakeholders and actors with their own interest, it is imperative the have research on the policy and governance aspect of FLR in light of SDG. Therefore, this session is inviting scientific work in the domain of FRL and SDG in the context of policy and governance. particularlly refering to; a) community people's role in FLR, b)FLR program in achieving countries SDG targets, c) FLR policy analysis, d) Governance issue in FLR, and e) FLR in terrms of eco-centric, ecological restoration to human livelihoods and biodiversity conservation.

Md Nazmus Sadath[1, 2] , Carsten Schusser[3]

[1] Professor, Khulna University, Khulna, Bangladesh

[2] Deputy Coordinator working party 9.05.06 on Community Forestry Under division 9

[3] Assistant Professor, Chair of Tropical and International Forestry, Tharandt, Germany

Forest management solutions under global change: connections between tree breeding, intensive silviculture and wood quality

Unprecedented levels of current and projected global change place increasing pressure on world forest resources and pose new challenges to forest management. There is a clear need for more responsive management guidelines to ensure resilience of forests and adaptation to extreme climate events. Bioeconomy solutions require forests to provide green alternatives to carbon-intensive materials, such as lumber and wood-based engineered products for construction, as well as feedstocks for biomaterials and biochemicals. Long-lived tree species are likely to become maladapted in the face of relatively rapid climate change, leading to reduced stand productivity and delayed harvests. Furthermore, climate-related disturbances such as wildfires can cause significant mortality within forests. These risks must be reduced to protect current and future timber supply.

To address these challenges, intensive management practices have been implemented to increase forest productivity and shorten production rotations. Shorter rotations have higher return rates for landowners, reduce the risk of maladaptation from climate change, as well as reduce exposure of valuable crops to climate-related disturbances. Tree breeding has selected high-performance genotypes adapted to a variety of growing environments for a wide range of commercially important forest tree species. Moreover, recent technological advancements have significantly shortened breeding cycles. At the same time, intensive silviculture regimes have been devised to optimize initial planting densities, fertilization, and precommercial and commercial thinning. However, shorter rotations as the result of increased rates of growth have generally resulted in trade-offs by reducing wood quality, such as decreased average density and stiffness, increased propensity to twist in conifers. While the relationships between wood quality and tree breeding, and wood quality and intensive silviculture, respectively, have received a fair bit of attention in recent years, research on the interaction between tree breeding and intensive silviculture is still in its early days. The overall research goal is to increase forest productivity while maintaining reasonable levels of product quality.

New technologies (non-destructive, laser scanning, etc.) are opening up opportunities to quantify the impact of intensive silviculture and tree breeding on wood properties and their variability at multiple scales, as a prerequisite to assess the value of the final products. The validity of such tools needs to be further explored and expanded for various wood species and forest stand mixtures for a meaningful and rapid measurement of a large number of standing trees.

Cosmin Filipescu[1], Ignacio Barbeito[2], Marie Vance[3], Joseph Dahlen[4], Keith Jayawickrama[5], Stergios Adamopoulos[6]

[1] Canadian Forest Service, Canada

[2] Faculty of Forestry, University of British Columbia, Canada

[3] Ministry of Forests, BC, Canada

[4] University of Georgia, USA

[5] Oregon State University, USA

[6] SLU, Sweden

Forest resilience: the vision from belowground

Soils are the home to a large, diverse microbiome and are critical to carbon and nutrient cycling. The ecological functions of soil are crucial for the health and ecosystem services of forests. However, Forest ecosystems are globally impacted by climate change, wildfires, pest outbreaks, as well as invasions of exotic species. The resilience of forests to these disturbances largely depends on soil functioning. The role of belowground biodiversity and their interactions between different functional groups (for example, bacteria, mycorrhizal fungi, roots, soil fauna etc.) to increase the resistance of forests to stress is still largely unexplored and deserves a broader interest of foresters, ecologists, and soil scientists. This session will focus on soil ecological processes in relation to carbon, nutrient, and water cycling in relation to soil biodiversity and the phylogenetic identity of tree species. It also addresses the responses to management practices, climate change, and disturbances. Our session will cover a wide range of topics in plant-soil interaction, and support policymakers in making decisions about forest protection and management, especially under the background of global climate change, biodiversity decline or species loss. This session is closely related to congress THEME 1: Strengthening forest resilience and adaptation to stress, and THEME 3: Forest biodiversity and its ecosystem services, and THEME 4.1 Nature-Based Solutions.

Junwei Luan[1] , Frank Berninger[2], Scott X. Chang[3], Ho Sang Kang[4], Alexia Stokes[5], Shirong Liu[6]

[1] Institute of Resources and Environment, International Centre for Bamboo and Rattan, China

[2] Department of Environmental and Biological Sciences, University of Eastern Finland, Finland

[3] Department of Renewable Resources, University of Alberta, Canada

[4] Institutes of Green-Bio Science and Technology, Seoul National University, Republic of Korea

[5] National Research Institute for Agriculture, Food and Environment (INRAE), France

[6] Ecology and Nature Conservation Institute, Chinese Academy of Forestry, China

Forest Restoration Success and How to Achieve it

This session will examine forest restoration success, factors critical to achieve it, and evaluation strategies to help monitor progress and get there. Given the extensive level of degradation across the tropical landscape, there is a clear need for natural and assisted recovery. How do we know when a restoration project is successful? One needs to identify the desired endpoints and restoration goals and then devise an evaluation and monitoring scheme to track progress toward those endpoints and goals. Goals for restoration can be social, economic, and ecological, running the gamut from survivorship of trees planted to direct and indirect impacts on local livelihoods. Important factors include available financing, decision-making by local people, land tenure, supportive policies, effective governance, project operations, preparatory training, age and gender diversity of restoration participants, livelihood incentives, and market access. Evaluation components to consider include diverse monitoring and verification approaches at various scales. Tools and strategies that can help projects identify problems and correct course during implementation and are of special interest in this session. Presentation topics for this session will include: setting goals for restoration, case histories and meta-analysis of tropical restoration projects, application of standards, developing evaluation tools and strategies, effectiveness of monitoring and evaluation, requirements from funders for evaluation, barriers to carrying out monitoring and evaluation, deployment of citizen science approaches to monitoring, and difficult problems still to solve in evaluation of restoration projects, among others.

Yitbarek Tibebe[1] , Paula Sarigumba[2], Nathaniel Anderson[3], Palle Madsen[4], Roger Villalobos[5, 6], Sheila Ward[7, 8], Samuel Olalekan OLAJUYIGBE[9], W. Keith Moser[10, 11], Douglass F. Jacobs[12, 13]

[1] Centre for Agroecology Water and Resilience, Coventry University

[2] Veritree Canada

[3] U.S. Forest Service, Rocky Mountain Research Station

[4] InNovaSilva ApS

[5] Tropical Agricultural Research and Higher Education Center (CATIE), Costa Rica

[6] Deputy Coordinator 3.09.00 Sustainable forest operations for forest landscape restoration

[7] Executive Officer, International Society of Tropical Foresters, Puerto Rico

[8] Coordinator IUFRO 4.02.01 Resource Data in the Tropics, Deputy Coordinator IUFRO 1.02.04 Tropical and Subtropical Silviculture

[9] Department of Forest Production and Products, University of Ibadan, Nigeria

[10] Rocky Mountain Research Station, US Forest Service, USA

[11] President, International Society of Tropical Foresters; Deputy Coordinator IUFRO 1.01.05 Mountain Forestry; Deputy Coordinator IUFRO 1.10 Long-term research on forest ecosystem management in Northeast Asia

[12] Tropical Hardwood Tree Improvement and Regeneration Center, Purdue University, USA

[13] Coordinator IUFRO 1.06.00 Restoration of Degraded Sites

Forest restoration under climate change in Southeast Asia: innovative tools, model, and approaches

Southeast Asia has experienced the highest deforestation and degradation from human activities over the past few decades. The loss of healthy native forests has had profound negative impacts on biodiversity and critical ecosystem goods and services, including carbon sequestration, affecting the livelihoods of millions of people in the region. Accordingly, interest in ecological restoration has been growing in the region. However, much of the restoration effort to date has had limited success in terms of establishing fully functional, self-sustaining ecosystems, as many restoration programs have focused on simple monocultures of fast-growing exotic tree species at large scale without considering biophysical, socio-economic, and complexity of integrating multiple benefits of the restoration sites. Further, this situation of restoration of the forest ecosystem is complicated due to changing climate in the region. In particular, the predicted shift in suitable climatic conditions for forest trees and ecosystems under climate change presents a challenge for large-scale restoration of deforested and degraded forest ecosystems. This technical session brings key researchers (established and early career) together to discuss and synthesize current approaches and tools to identify changes in tree species and ecosystem in Southeast Asia, model the impact of anticipated climate changes on forests, and approach site-specific restoration that ensure local communities life and livelihood under climate change so that it guides stakeholders for forest restoration and planning within the context of climate change.

Guangyu Wang[1]

[1] Faculty of Forestry, University of British Columbia

Forest Tree Breeding in the Context of Climate Change and Bioeconomy Development

Forest tree breeding started in the 1950's with the launch of large breeding programs for both conifers and broadleaves. Genetically improved germplasm is currently widely available for reforestation to increase wood production, wood quality as well as adaptation to biotic and abiotic constraints. As planted forests face new challenges due to climate change and to the diversification of wood uses, breeding programs have to integrate new selection criteria, to speed up breeding cycles and to explore wider genetic diversity. Tree breeding should aim to overcome these challenges by being more efficient using the latest advances in genomics, phenotyping and computing.

This technical session aims to share the latest research activities in forest tree breeding. The session will include:

- Innovative breeding strategies (from genomic selection in advanced breeding programs to low-input breeding strategies for diversification species)
- New selection criteria based on phenotyping / screening platforms to cope with climate change and bioeconomy development
- Integration of environmental factors into the genetic evaluation process
- Management of diversity in the breeding population for long-term genetic gain and infusion of new genetic resources
- Deployment issues in a context of climate change (seed orchard management, clonal forestry, deployment of variety mixtures, assisted migration)
- New mating designs based on computer-generated algorithms
- Interactions of breeding with silvicultural practices

Laurent Bouffier[1] , Christophe Orazio[2], Ricardo Alía[3], Santiago C. González-Martínez[1], François Lefèvre[1], Henrik Hallingbäck[4], Catherine Bastien[1], Léopoldo Sanchez-Rodriguez[1], Fikret Isik[5], Jaroslav Klapste[6]

[1] BIOGECO, INRAE, France

[2] IEFC, International

[3] CSIC-INIA, Spain

[4] Skogforsk, Sweden

[5] North Carolina State University, USA

[6] Scion - New Zealand Forest Research Institute, New Zealand

Forest Wetlands as Nature Based Solutions for Water, Biodiversity and Climate

Wetlands stand out for the contribution they make to ecosystem services in many forest landscapes. Managing these wetland areas as nature-based solutions for biodiversity, water and greenhouse gas mitigation will help the forestry sector to contribute to the vision of Agenda 2030. The smart design of working landscapes can maximize food/wood/fiber/energy production while protecting the ecosystems, biodiversity and climate that are so essential to the UN Sustainable Development Goals. Unfortunately, extensive wetlands have already been lost and those that remain are the most threatened ecosystem on the planet. Around the world, the rates of wetland degradation and destruction place crucial functions and associated ecosystem services at risk. The value of ecosystem services from these vulnerable wetlands in the United States is estimated to be billions of dollars per year. A large portion of this value relates to supporting a prosperous bioeconomy. The positive side to this current situation is that there are great opportunities for improving the contribution of wetlands to the UN SDG in forest landscapes through better management and restoration. To realize that potential requires two things. The first is to advance the scientific understanding of wetland hydrological, biogeochemical and ecological functions. The second is to manage these functions as nature-based solutions (NbS) - defined as actions to protect, conserve and restore natural ecosystems that address societal challenges while simultaneously contributing to human health and well-being . This is an integrated approach to promoting synergies/co-benefits while reducing trade-offs among the SDGs. For example, NbS seek to maximize production (and resilience) in forestry while sustainability managing land, water, biodiversity and reducing GHG emissions. If properly deployed, NbS can contribute to the triple bottom line – social, economic and ecologic benefits – and support a thriving green economy. There are however many challenges and trade-offs to be considered. This requires both fundamental process knowledge that applicable in many settings, and a holistic awareness of what is unique to specific socio-ecological settings. This session will highlight advances in the evidence-base for management and governance of wetlands in the forest landscape as nature-based solutions for achieving Agenda 2030.

Kevin Bishop[1, 2] , Irena Creed[2]

[1] Swedish University of Agricultural Sciences, kevin.bishop@slu.se

[2] University of Toronto, Canada, irena.creed@utoronto.ca

Fostering modern forest and landscape restoration based on climate-smart use of forest genetic resources and innovation: from policy to practices

Forests in the landscape are vital to human well-being. They provide nature's benefits to people, safeguard biodiversity, genetic resources and provide raw material and inspiration for a booming bioeconomy. However, despite efforts to halt deforestation and restore degraded lands, global forest cover continues to shrink. At EU and global level, a growing attention is given to Forest and Landscape Restoration (FLR) interventions, which can contribute to regain ecological functionality, forest resilience and resistance to hazards while enhancing human wellbeing. Governments and markets have started to design land use policies that are more proactive in maintaining and restoring forests and other ecological ecosystems, while scientists, professionals and practitioners have started to realize restoration projects in the field (e.g. reforestation after extreme events like storms or big forest fires, as well as forest-based adaptation solutions to climate change and more). Under changing environmental conditions and social demands, forest genetic assets are central to sustaining social-ecological resilience, while their production, use and management as well as related technical, social, political and governance implications are not yet comprehensively understood. Unfortunately, most government-and market-led initiatives in this direction have not responded with the agility and intensity required by an increasingly dynamic and connected society that demands greater efficiency and transparency in managing restoration interventions, with multiple ecosystem services and related trade-offs deriving from complex landscapes management. In parallel, organized rural workers, indigenous peoples, women, and youth have been leading or actively participating in the design, implementation, and evaluation of innovative solutions of FLR, often invisible to the public authorities and marketing, but with immense potential to improve or regenerate the social-ecological system in which they live and to leverage broad transformative processes.

The present sub-thematic section aims to portray practical examples and deepen the theoretical debate on FLR approach, to reveal examples of diverging or converging interventions, with a focus on the role of forest genetic resources in finding innovative solutions. The section is inspired by the Horizon Europe project OptFORESTS, but it is intended towards opening broader perspectives on these emerging issues that are relevant for the future of the forests worldwide.

Effective implementation of forest-landscape restoration initiatives poses several challenges and raises questions to researchers, policymakers, and practitioners: How can FLR initiatives fulfil their innovative potential? Which policy instruments stimulate local nature-based solutions FLR? How do the forest genetic resources contribute? What is the landscape approach relevance in defining policy and technical instruments?

Aurelio Padovezi[1, 2] , Mauro Masiero[1], Laura Secco[1], Todora Rogelja[1], Monica Gabay[3], Santiago C. González-Martínez[4], Francois Lefevre[4], Andreas Bolte[5], Davide Pettenella[1]

[1] UNIPD-ITA

[2] USP-BR

[3] MESD-ARG

[4] INRAE-FRA

[5] Thünen institute-GER

Genomics of Keystone and Underused Forest Genetic Resources for Their Climate Adaptation, Resilience, Conservation and Sustainable Management

Natural and anthropogenic disturbances, such as deforestation, fragmentation, insect and disease outbreaks and climate and environment change are major threats to the conservation and sustainability of forests, stability and functioning of forest ecosystems and the services they provide. Genetic diversity is the basis of all biodiversity because it provides the raw material for survival, adaptation and evolution of all organisms, especially under changed environment, climate and disease conditions. Therefore, conservation and management of genetic diversity in forest trees is critical for the stability and functioning of forest ecosystems because forest trees are normally the keystone species of many ecosystems, and many faunal and floral associations depend on their existence. Consequently, genetic diversity of forest trees provides the foundation for forest sustainability and ecosystem stability. Our understanding of the genetic diversity and population structure of forest tree species and genetic impacts of forest management practices and natural disturbances is rapidly progressing, but genetic resources of numerous ecosystems and species are endangered and may face extinction. Therefore, it is paramount to understand and harness underused forest genetic resources, and conserve and protect genetic resources of rare and endangered tree species. Such resources include both keystone, rare and endangered species for maintaining ecosystem functions and services. It is paramount to understand how forest genetic resources contribute to ecosystem integrity and promote their diverse and sustainable use to foster adaptation to climate change. Moreover, in order to advance measures to mitigate the negative impacts of climate change by developing and managing well-adapted, genetically diverse and healthy forest resources, it is critical to understand the genetic basis of local adaptation and that of responses and adaptation to climate change in forest trees. Emerging population, functional, ecological and conservation genetics and genomics approaches, enhance the opportunities to address these critical forest genetics research needs. The session will explore the progress and promises of forest genetics and genomics research, including AI and Internet of Things (IOT), for the conservation of forest genetic resources and understanding adaptation in forest trees with the objective to define priorities for future research in order to maximize its impact on genetic biodiversity conservation, adaptation and sustainable forest management, especially under the climate change conditions. The Session will encourage presenters to address issues of improving the livelihoods of local communities through forest genetic resource conservation and breeding, as well as issues access and equitable sharing of benefits derived from genetic resources.

Filippos Aravanopoulos[1] , Om Rajora[2], Konstantin Krutovsky[3], Chuanping Yang[4], Wickneswari Ratnam[5], Silvio Schuler[6]

[1] School of Forest and Environmental Science, Aristotle University of Thessaloniki, Greece

[2] Faculty of Forestry and Environmental Management, University of New Brunswick, Canada

[3] Department of Forest Genetics and Forest Tree Breeding, Georg-August University of Göttingen, Germany

[4] Coordinator IUFRO 2.00 - Hardwood improvement, culture and genetic resources

[5] Deputy Coordinator IUFRO 2.00 - Hardwood improvement, culture and genetic resources

[6] Head, Department of Forest Growth, Silviculture and Genetics, Austrian Research Centre for Forests

Improving biosecurity measures to better protect forests

Alien forest pests and pathogens continue to be spread globally through increased globalization and international trade. When established they can have devastating impacts on native, urban and commercial forests. In this session we discuss control and management tools to minimise the impacts of non native invasive pests and pathogens, as well as highlight new and emerging risks, and the threats they pose to forest ecosystems. Emerging risks include those where abiotic factors such as climate change may provide a changing environment conducive to insect and disease outbreaks.

Beccy Ganley[1] , Julio Diez[2], Barbara Bentz[3], Hervé Jactel[4]

[1] Plant and Food Research

[2] Universidad de Valladolid

[3] USDA

[4] INRAE

Increasing the potential of natural regeneration in restoring degraded forest and deforested lands around the world: concepts, strategies, experiences and guidelines

Currently, there is an ambitious set of international goals to increase the area and productivity of forests worldwide by afforestation, reforestation, and sustainable management to mitigate the drivers of climate change and increase forest adaptability, compatibility, and resilience to expected future climate, environmental stresses, and disturbances. For example, the Bonn Challenge aims to restore 350 million hectares of forests by 2030. In some countries, regenerate from natural sources and processes; in Germany 85% of forest regeneration occurs naturally, and 98% of forests in the US regenerate naturally. Natural regeneration is a relatively cost-effective means to renew or restore forests, and therefore is desirable considering the goal to increase and improve forests at a large scale globally. Most countries, states, communities, and organizations have limited funds, staff and resources that would argue for natural regeneration. We have identified a need to provide a practical guide on natural regeneration for major global forest biomes. The guide would include a synthesis of basic concepts and processes, drivers and barriers, practices and prescriptions, and recommend strategies, approaches and best practices. Clearly, the goal formulations, risks and uncertainty together for each single project make up the overall strategy, in which artificial regeneration also has a role. We would cover how to integrate species silvics requirements (e.g. for particular lifecycle stages) to secure adequate regeneration, promote the development of desired species, manage competition, and control adverse biotic and abiotic factors and conditions. This would also mean identifying the limits of natural regeneration and considering how artificial regeneration techniques (e.g. sowing and planting) can be used as an alternative or complementary.

Examples from forest biomes from around the world would illustrate general principles and regional and local differences and facilitate learning from failures and successes. We are currently developing the natural regeneration guide and should have a maturing product by the time of the IUFRO World Congress in June 2024. The intended final product will be an IUFRO publication that we would like to highlight and share in a technical session at the World Congress.

Daniel Dey[1] , John Stanturf[2], Sven Wagner[3]

[1] Assistant Director Research, Northern Research Station, US Forest Service

[2] Senior Researcher, Forest Restoration Specialist, InNovaSilva ApS, Vejle, Denmark

[3] Professor, Technische Universitat Dresden, Germany

integrated forest management in temperate and boreal forests – balancing biodiversity and ecosystem services

About 31 % of the world's land surface is covered by forests and these host about 80 % of the worldwide biodiversity. More than 75 % of the world's freshwater comes from forest watersheds and one third of the world's population depends on fuel wood from forests for cooking and heating. Forests play a crucial role for local climate, but also for the worldwide climatic trends. Considered as carbon sinks, the loss of about 10 million hectares of forest every year needs be stopped. However, demands for forest products and ecosystem services have continued to increase. Managing forests is becoming increasingly complex, due to rapidly changing environmental conditions and an ever more sensitised society expressing their views and demands towards forests and their management. The traditional forest manager as the only steward of our forests has become somewhat outdated. The unidimensional focus on biomass production, varying in intensity and duration depending on region, has continuously led to a narrowed view on forest management and also education. Novel management approaches are urgently needed to better make use of forests for people while respecting nature and avoiding negative impacts on forest ecosystems and their services for society. Integrated forest management is a concept that considers the view to the landscape scale and embraces local conditions and history. It focusses on the potential to combine maintenance and enhancement of biodiversity with providing ecosystem services. Such approaches allow to prioritise management based on societal/local needs and conditions and are dedicated to improving specific ecosystem services.

Our session aims at highlighting the complexity of a worldwide perspective on forests. Based on specific views, the presenters will introduce pathways on how to integrate biodiversity to forest management, from their own perspective. The panel discussion and a concluding synthesis at the end given by the session organisers will point towards the need to think in an integrative way on the forests and their management, as part of living landscapes.

Frank Krumm[1] , Andreas Schuck[2], Jurij Diaci[3], Andreas Rigling[4], Lena Gustafsson[5]

[1] Ecosystem ecology, Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Switzerland

[2] European Forest Institute EFI, Germany

[3] Department of Forestry and Renewable Forest Resources, University of Ljubljana, Slovenija

[4] Department of Environmental Systems science, ETH Zürich, Switzerland

[5] Department of Ecology, SLU, Uppsala

Legacy tropical forest data: current status, uses, and securing them

Legacy tropical forest data are older datasets. Over the years, these data have been generated from many projects, and they are now scattered among various institutions and people. Many of these datasets are on paper or in older digital formats, and therefore in danger of being lost. But these data have many potential uses. They are valuable for understanding how tropical forests have changed through time, including the cumulative impacts of change in land use and climate, and changes in patterns of biodiversity and carbon storage. They can serve as guidelines for forest restoration to previous conditions, or to projected conditions with climate change (using data from relevant sites). Many of the forests (e.g., in Nigeria and Ghana) represented in historical datasets no longer exist, so these data are the only record of the natural vegetation of the area.

This session will focus on the current status of these data, their uses, and what needs to be done to secure them. We especially seek contributions from researchers based in tropical countries. We want to consider possible uses of these data for tropical forest restoration and research on long-term forest dynamics. We are also interested in current work using these data for biodiversity/biogeography studies, such as from the DryFor and TreeCo networks; and gaps in the spatial distribution covered by older datasets, such as for African montane forests.

We aim for the last part of the session to be a discussion, with questions from the audience and discussion among the presenters and moderators. We hope to find common research themes among participants to help build possible collaborations. We also welcome poster presentations for this session. This theme should be interesting for Congress participants, with the increasing global focus on forest restoration.

Hans Jürgen Boehmer[1,2], Sheila Ward$_2$, Adriane Esquivel Muelbert[3], Gillian Petrokofsky[4]

[1] Institute of Geobotany Leibniz University of Hannover Germany

[2] International Society of Tropical Foresters, Puerto Rico USA

[3] Birmingham Institute of Forest Research, University of Birmingham UK, T ask Force Deputy Coordinator Monitoring global tree mortality patterns and trends

[4] University of Oxford UK, 9 Coordinator WP9.01.01; Deputy Coordinator WP4.02.01

Managing forest genetic resources for multi-purposes for forest products, ecosystem services and response to climate change

Forest genetic resources (FGR) are genetic material with actual and potential values from forest plants and contain genetic functional unit. FGR is the major carrier of forest biodiversity at the levels of ecosystem, species and gene, and contributes to the provision of forest products and ecosystem services, and the capacity of mitigation of and adaptation to climate change. The diversity of FGR allows tree populations be managed to have high productivity of timber and non-timber products, enhanced functions of ecosystem services, increased sequestration and storage of carbon, and stronger adaptability to climate change. Understanding of FGR diversity is essential for the development and application of sound FGR management strategies to achieve the multiple purposes. Key issues include optimization of genetic diversity and genetic gain in multi-generation breeding programs to maximize productivity while maintaining high diversity to avoid loss of long-term potential, identification of appropriate FGR management models to be applied in afforestation programs for increased productivity, enhanced ecosystem services, and expanded uses of FGR with high potential for carbon sequestration and storage, and for high resilience to adapt to climate change. However, FGR is facing serious threats due to habitat loss and degradation caused by inappropriate FGR management practices, such as deforestation, fragmentation and over exploitation.

The proposed technical session is to provide a platform for the international community of scientists and researchers engaged in FGR to share recent achievements in FGR management for enhancing productivity, ecosystem services and mitigation and adaptation to climate change. The technical session will include oral and poster presentations. Participation from world wide is hihgly welcome. Research students involved in FGR studies are highly encouraged for participation. It is intended to create an international forum for discussions about the management of FGR on issues identified by the technical session, and to draw a wider attention from the FGR policy makers, scientists and researchers, and forest managers. The topics of potential presentations may cover a broad range of studies in the value chain of FGR, particularly those underused FGRs, including inventory, collection and conservation, documentation and database development, evaluation and monitoring. Presentations on FGR management, conservation and sustainable use are all welcome.

Yongqi Zheng[1] , Riina Jalonen[2], Kyu-Suk Kang[3]

[1] Institute of Forestry, Chinese Academy of Forestry, China

[2] Asia-Malaysia Office, Alliance of Bioversity International and CIAT, Italy

[3] Department of Forest Sciences, Seoul National University, Korea

Mini-Symposium: Resilience of Forest Biodiversity to Climate Change and Pests: Civic Engagement and Conservation in Seed Banks, Public Gardens, and Wild, Urban, and Agroforestry Landscapes

To conserve biodiversity, multiple approaches can be taken on the ground. This mini-symposium (Panel, Flash-talks & Posters) represents experts who focus on complementary aspects of conservation and reforestation; threat assessment, seed collecting and banking from wild trees, collective action and civic engagement, the roles of public gardens in conserving genetic resources, developing genetic resistance to pests to conserve biodiversity, and the importance of conserving genetic diversity in the face of pests and climate change.

Seed is the unit by which biodiversity is propagated, and therefore, protected. There is ever increasing pollination disruption with shifting local climate conditions and more fragmented and degraded native ecosystems. As forests and genetic diversity are lost, so are mother trees for seed collection, in a time when people want to greatly scale reforestation efforts. In addition to potential declines in seed crops, global trade, biodiversity loss, and fragmentation increase the threat of emergent insect and pathogen outbreaks, resulting in local or range-wide extinction of iconic tree species. Therefore, there is a global need for threat assessments, seed collection and banking of native tree species.

In the context of the above challenges and solutions, public gardens and arboreta are critical to the resilience of forests and society. In addition to acting as living collections, seed sources, and refugia of tree species, public gardens serve as biodiversity hotspots in cities, and meeting places for public and volunteer conservation efforts and outreach. As sentinels, trees in public gardens can be used to proactively detect emergent disease threats. Through collective action, exchange of information, public engagement, and local expert knowledge, "think global, act local" could be applied to aid proactive efforts to protect forest biodiversity from the next major pests across the world. Local experts and civic ecologists can accomplish this by collecting seed and observing trees in native environments, plantations, public gardens, and urban forests.

Breeding or human-directed genetic improvement presents a practical solution for restoration of species that are impacted by emergent pest epidemics, climate change, or other threats. The utility of breeding to protect biodiversity also depends on the prior establishments of seed banks and other germplasm resources. It is critical to generate a prior understanding of the diversity of populations of tree species valued for their ecological, horticultural, or economic and commercial characteristics, the observed or potential effects of threats to those populations, and the role diversity could play in recovery of species.

Jill Wagner[1] , Geoffrey Williams[1, 2, 3], Denita Hadziabdic-Guerry[4], Sean Hoban[5, 6], Lara Salido[5, 7]

[1] International Society of Tropical Foresters

[2] USDA Forest Service International Programs, USA

[3] Society of American Foresters, International Forestry Working Group, USA

[4] University of Tennessee-Knoxville, USA

[5] Botanical Gardens Conservation International

[6] Morton Arboretum, Chicago, USA

[7] Kew Gardens, UK

Minimizing forestry impacts on water quality, aquatic biodiversity and ecosystem functions

Provision of clean water is one of many ecosystem services that is required from world's forests. Yet, forestry operations such as final felling, site preparation, road construction, drainage or ditch cleaning can cause large negative effects in aquatic ecosystems. Alterations of hydrological regimes, increased sediment transport, increased light and water temperature, and increased solute concentrations are just a few prominent examples that have been documented to follow forestry operations. Further, those physicochemical changes inevitable lead to responses by aquatic organisms at all levels of the food web, which can also be followed by large shifts in ecosystem functioning. This is in sharp contrast with many local and transnational policies that require safeguarding or improving biodiversity, achieving a good ecological status of all surface waters, and using natural resources sustainably. Over the past decades, a number of strategies for the protection of water quality, quantity and aquatic ecology have been used. For example, maintaining riparian buffers, strips of unharvested forests, along water courses to mitigate harvesting effects has become standard in many countries where clearcut forestry is practiced. Furthermore, there are many 'best practices' (albeit not well tested) for mitigation of impacts from ditch cleaning in peatland forestry such as sediment pits and ponds. Additionally, new technologies, such as process-based models and biochar filters, along with new forest harvest methods, like selective logging, are emerging trying to protect surface waters. Yet, studies are still finding that aquatic ecology and water quality are at risk in forests that are managed for timber production. It is clear that novel and improved solutions for how to protect our freshwaters are urgently needed. These solutions must be based on advanced scientific understanding of freshwater responses to operations as well as an improved dialogue between scientists and the forestry sector. Furthermore, protecting our waters must be well balanced between societal, economic and ecological needs. This session will present up-to-date research on forestry impacts on freshwaters, describe various protection measures and best-management-practices in forestry and promote a dialogue between all invovled stakeholders.

Lenka Kuglerová[1] , Eliza Maher Hasselquist[1]

[1] Swedish University of Agricultural Sciences, dept. of Forest Ecology and Management

Mitigating zoonotic and vector-borne disease risk in transformative forestry

Epidemics and pandemics - most of them caused by zoonotic and vector-borne emerging diseases - are globally threatening our health and welfare at an alarming pace. Examples include COVID-19, HIV, Monkeypox, malaria and Zika and orthohantavirus infections. Prevention of future disease outbreaks will be pivotal to secure human welfare and demands transformative change. Intensified land use, including intensive forestry, is one of the most important drivers of disease risk due to amongst others habitat degradation, biodiversity loss and encroachment into the habitat of pathogen hosts, reservoirs and vectors. "Biodiversity-is-good-for-our-health" has become a new paradigm in disease risk mitigation. Consequently, forest restoration, including close-to-nature and continuous cover forestry, targeting biodiversity recovery has been identified as a major disease risk mitigation tool. So far, we lack however guidance on how forest restoration should be performed to mitigate disease risk.

The session aims to a) demonstrate disease risks associated with intensive forestry, b) identify best practices and discuss if various less intensive forestry approaches such as close-to-nature and continuous cover forestry could help mitigate the disease risk in forest ecosystems and forest dominated landscapes and c) start preparing a roadmap for transformative forestry that favours ecosystem health and minimizes disease risk from zoonotic and vector-borne pathogens.

Frauke Ecke[1] , Magnus Magnusson[2]

[1] Organismal and Evolutionary Biology Research Programme, University of Helsinki, Finland. Department of Wildlife, Fish, and Environmental Studies, SLU, Sweden

[2] Swedish Forest Agency, Umeå, Sweden

Multi-disciplinary approaches to the modelling of FGR resilience: there's more than genetics to Forest Genetic Resources

The monitoring and conservation of Forest Genetic Resources (FGR) rests primarily on indicators describing the genetic diversity of forest stands.These indicators are essential as they summarise at least some aspects of adaptive potential, and because populations with too low genetic diversity risk falling into an extinction spiral.

Notwithstanding the dearth of information that can be extracted from genetic data, this is likely to be insufficient to describe the short- and long-term capacity of forests to buffer the disturbances caused by drivers such as climate change and to persist in the long term.

Interdisciplinary research involving tree physiology, population biology, ecosystem ecology, evolutionary biology, and genetics, and resting on methods such as remote sensing, machine learning, and modelling is necessary to correctly assess all components of forest resilience. Ongoing research programs such as Horizon Europe-funded FORGENIUS and OptFORESTs aim at synthesising results from multiple research fields to identify which characteristics can drive forest resilience and vulnerability. In particular, it is essential to look closely both at plastic, short term, responses and evolutionary, long term adaptive capacity.

In this session we will hear from research and management actions based on multidisciplinary approaches to assessing and preserving forest resilience, and discuss their respective benefits and drawbacks, their complementarities, as well as their respective application ranges.

Ivan Scotti[1] , François Lefèvre[1], Marjana Westergren[2]

[1] INRAE

[2] Gozdarski Inštitut Slovenije

New forests with greater resilience: the importance of forest genetic resources in forest landscape restoration

Climate change impacts and anthropogenic activities have destroyed vast tracts of forest across the globe. Forest Landscape Restoration (FLR) is a planned national, international, and global process that aims to restore degraded forest land to increase ecological functionality and human well-being. Research has shown that nearly 2 billion ha of land is suitable for FLR, but these future forests will have to have high resilience to withstand growing climate change impacts. One strategy for handling these pressures is to carefully manage levels of genetic diversity in forests restored by humans to ensure adaptive potential. This session invites presentations on how forest genetic resources can be effectively deployed during the planning, initiation, establishment, and future management of forests restored under the FLR. The session will focus on five thematic questions:

1. How can we effectively deploy the genetic diversity of native trees, herbs, and shrubs during forest restoration?
2. How can multifunctional use of forests (e.g., multipurpose trees, biomass, non-timber forest produce, etc.) be enhanced through genetic resource management?
3. Which forest management and silvicultural interventions can be used in FLR to increase gene flow?
4. How should we plan tree breeding programs to increase environmental and disease tolerance without compromising the natural genetic diversity of the population?
5. How can we integrate FGR management with the nursery sector at national and international levels to ensure supply of high quality, genetically diverse planting stock?
6. How we can produce seeds and plants to implement commitments under the UN Decade on Ecosystem Restoration, and regional Initiatives such as 20x20 in Latin America and AFR100 in Africa?

The session will have a global focus comprising FLR and forest genetic resources in all terrestrial forest ecosystems. Submissions linking FLR activities to forest genetic resource management from less-studied forest ecosystems will be welcomed. This interdisciplinary session aims to bring together foresters, forest owners, forest geneticists, silviculturists, nursery sector representatives, and biologists in presentation and discussion.

Somidh Saha[1] , Santiago C González-Martínez[2], Palle Madsen[3], Douglass F. Jacobs[4], Stephen Cavers[5], René Zamora Cristales[6]

[1] Research Group Sylvanus, Institute for Technology Assessment and Systems Analysis (ITAS), Karlsruhe Institute of Technology (KIT), Germany

[2] INRAE, French National Research Institute for Agriculture, Food and Environment, France

[3] InNovaSilva ApS, Denmark

[4] Purdue University, USA

[5] UK Centre for Ecology & Hydrology, UK

[6] World Resources Institute, USA

Opportunities to promote biodiversity recovery and protection through innovative forest management approaches

Forests have faced significant change and loss through anthropogenic activities over the last few millenia due to felling of trees for timber or land clearance for agriculture. Today, along with these factors, new pressures have emerged that threaten forest integrity including climate change and invasive species, both exacerbating forest degradation. Intensive forest management practices (e.g. large scale clear-felling, plantation establishment, prescribed burning), that have become prevalent across the globe in the last century have led to significant declines, loss and extinctions of forest biodiversity across all faunal and floral taxonomic groups from the soil to the canopy. Biodiversity underpins many crucial ecosystem functions from nutrient cycling, food web stability (e.g. regulation of herbivores by predators), pollination and seed dispersal. Continued loss is likely to see negative impacts on the associated ecosystem services provided by these functions. Further, as well as the intrinsic value of biodiversity, forest-associated species can have significant value to cultures across the globe. The challenge is to determine how environmental changes impact forest biodiversity (and associated ecosystem services) and to seek out innovative mitigation measures through improved sustainable forest practice. Our session will address this challenge by exploring the impacts of a variety of forest management approaches on biodiversity and will pose novel solutions to mitigating these impacts. Presentations in this session will seek to address this challenge; they may include one or more aspects of forest biodiversity, from soil to canopy. They will also include those addressing novel forest practices or using state of the art technologies. Outcomes of all presentations will include evidenced based solutions for forest management.

Anne Oxbrough[1] , Mónica Toro Manriquez[2], John Devaney[3], Marion Vinot-Gosselin[4]

[1] Edge Hill University

[2] Centro de Investigación en Ecosistemas de la Patagonia

[3] Maynooth University

[4] Institut national de la recherche agronomique

Reforestation Under Drought Conditions

Droughts associated with climate change are increasing in frequency, intensity, and duration across much of the world resulting in unforeseen effects on forest regeneration in temperate, tropical, and boreal forests. Ensuring sites and landscapes are successfully reforested is critical for meeting global forest restoration initiatives such as the Bonn Challenge, yet many of the areas committed to restoration are or have experienced recent droughts hindering regeneration survival and threatening forest sustainability. In addition, global wood demands are increasing with an increasing global population, which increases pressure to reforest lands following harvesting. Many countries have established ambitious reforestation targets, yet reforestation failures under drought conditions are still common. There is a need for greater understanding of the ecology of regeneration under drought, how regeneration physiologically responds to drought, and how nursery propagation and silvicultural strategies can possibly be employed to increase reforestation success. This session will have submissions focused on (i) ecology, regeneration physiology and morphology of forest regeneration under drought conditions, and (ii) seed, nursery, and silvicultural strategies for improving regeneration success under drought. We will bring together global experts and students in the field of reforestation with particular emphasis on drought conditions to share new findings and thoughts for how to increase reforestation success across different forest biomes under a drier future. The session will include short oral presentations by students, early career professionals, and established scientists, as well as a poster session and a round-table discussion comprised of experts in the field of reforestation-drought interactions.

Andrew Nelson[1] , Carlos Gonzalez-Benecke[2], Ben Du Toi[3], Otávio Campoe[4], Horacio Bown[5]

[1] University of Idaho

[2] Oregon State University

[3] University, South Africa

[4] Universidade Federal de Lavras, Brazil

[5] Universidad de Chile, Chile

Research advances towards sustainability for the high-value Meliaceae

Tropical timber species of the Meliaceae are among the world's finest hardwoods, and are widely distributed in Asia, Oceania, Africa, and Latin America. The family includes about 53 genera and about 600 known species, including the genera of *Swietenia*, *Cedrela*, *Toona*, *Entandrophragma* and *Khaya*. Demand for these species remains high, in spite of decreasing populations for many of the species, especially in the wild. Many species (e.g. mahogany, African mahogany, Chinese Toon, Australian red cedar) are being grown as plantations around the world (e.g. Australia, Malaysia, Brazil, China, and Nigeria). These sources can potentially reduce pressure on natural populations and provide highly desired wood products to society. However, the sustainable management of high value species of the family Meliaceae faces similar issues in the eastern and western hemispheres. In addition to timber, other products from these species also contribute to livelihoods for forest communities. Much research is still needed over a wide range of topics. The purpose of this session is to share the latest findings in research and management towards sustainability for these species, presenting insights from various countries. Important topics include conservation of genetic resources, genetic improvement, advances in shootborer control, natural forest management, carbon sequestration potentials, climate change adaptation, development of products useful for human health, improvement of yields from plantation-grown Meliaceae, and advances in science for Meliaceae wood and non-wood forest products.

We hope to broadly communicate advances made in research on these species for improved management and utilization, and to find common research themes among participants to help build possible collaborations. We aim for the last part of the session to be a discussion, with questions from the audience and discussion among the presenters and moderators. We also welcome associated posters for this session. This theme should be interesting for Congress participants, since demand remains high for Meliaceae wood in global markets.

Yanjie Li[1], Liu Jun[1,2], Antonio Ferraz Filho[2,3]

[1] Institute of Subtropical Forestry, Chinese Academy of Forestry, China

[2] IUFRO WP1.02.04

[3] Curso de Graduação em Engenharia Florestal, Federal University of Piauí, Brazil

The impact of introgressive hybridization on adaptive capacity of forest trees in the Anthropocene

The evolutionary role of introgressive hybridization (IH) in natural systems has become increasingly clear as genetic datasets grow in genomic density and taxonomic breadth. Introgression between sympatric species has been shown to be adaptive in certain environmental circumstances but has not been associated with a loss in species identity. In fact, introgression seems to be associated with maintaining adaptive capacity among participating species and responding to environmental change. The impacts of IH occur at many different temporal and spatial scales, from ancient diversification events to current species radiations. Our general understanding of IH, e.g. when and where it is adaptive versus maladaptive, what parts of the genome are easily introgressed, is now rapidly advancing but much remains to be discovered. Additionally, the complexity of IH often involves a suite of interfertile species, interacting over large geographic and temporal scales.

This increasing clarity and insight into the role IH has played in the past to maintain the adaptive capacity of species and populations is developing against the backdrop of rapid global change during the Anthropocene. These changes will involve many environmental factors and will clearly occur at a pace substantially faster than in the past. Not only will existing environments change quickly but novel environments, in terms of local climate, composition of ecological communities, and land use, will emerge, presenting new challenges to forest tree species. Human activity will also enhance the possibility of IH, particularly by creating secondary contact zones, both directly and indirectly. So, while the topic of IH would be compelling on its own, at any point in history, the prospect of unpredictable and rapid local and global environmental change demands that we examine the process closely and learn to manage introgressive hybridization to sustain adaptive capacity so that forest trees will continue to provide the many ecosystem and societal benefits they offer.

This session will be four-five 15 minute presentations that provide a comprehensive overview of major research programs and four-five 5 minute presentations on targeted results from specific research projects. The session will conclude with a 20 minute panel discussion amongst the speakers and the audience. The topics will involve both model and non-model groups, using both empirical and theoretical approaches. The panel discussion will focus on how our current understanding of IH and how it affects adaptive capacity of tree species can be translated into conservation and restoration management policies.

Charles Cannon[1] , Jill Hamilton[2], Steve Keller[3], Victoria Sork[4]

[1] The Morton Arboretum, Illinois, USA

[2] Pennsylvania State University, Pennsylvania, USA

[3] University of Vermont

[4] University of California, Los Angeles

The scientific basis for how to safeguard biodiversity in production forestry

Halting biodiversity decline and ensuring high levels of biodiversity are key issues for the sustainable future of our planet. Forestry is one of the driving forces behind biodiversity decline and the associated alteration of ecosystem services. Developing a forest management that ensure delivery of provisioning services without jeopardizing biodiversity is central for the possibility to develop a sustainable forestry.

Disturbance is a natural and central part of most forested ecosystems. For example, time since disturbance has a profound impact on the species community assemblages and thereby on the functionality for the forest. Alternation of the disturbance dynamics will usually result in large changes of biodiversity and ecosystem function. Forestry impose a strong disturbance that in most cases differ substantially from natural disturbances, and in many forest regions forestry has replaced natural disturbances as the dominating disturbance type, thereby pose a serious threat to biodiversity. Subsequently, forest operations that emulates the natural disturbance has been suggested as an important measure to mitigate some of the negative effects, and is commonly suggested as an important way to develop a more sustainable forestry. Although the idea that a forest management that emulates natural disturbances would promote biodiversity has been around for several decades, the scientific support demonstrating its functionality has been lagging behind. However, the situation has improved, and the main objective with this session is to highlight this improvement. The session will present some of the scientific support for the importance of maintaining legacy structures and the effectiveness of emulating natural disturbances to promote biodiversity in production forestry. The session will both give insight to the linkages between disturbance, biodiversity and ecosystem functioning, and differences and similarities between natural and forestry–induced disturbances. In addition, the session provides an expose of the different measures taken to mitigate forestry effects on biodiversity, focusing on key issues and the scientific support of different measures by including examples from different biogeographical regions.

Joachim Strengbom[1]

[1] Swedish University of Agricultural Sciences, Sweden

Top five business and policy innovation challenges to accelerate landscape restoration as a nature-based solution

Currently, there are 210 million hectares committed by 74 countries, states, and associations to the Bonn Challenge, through regional initiatives such as Initiative 20x20 and AFR100 to restore degraded landscapes around the world. Many governments have developed robust plans and strategies to prioritize areas for restoration under multiple environmental, social, and economic objectives. But once these processes are finished, restoration often stalls. Why? In this panel, we will address the five most common challenges experienced by countries around the world to turn plans into action.

In order to implement restoration on the ground, countries require coordinated financial resources from the public and private sectors., Restoration activities must generate multiple benefits to landowners and avoid encouraging further land degradation to ensure additionality and the permanence of restoration. Landowners can include communities, individuals, or companies. In many countries, resources from the public sector are scarce, which makes the implementation of sustainable practices and investments difficult. On the other hand, the private sector faces many barriers related to the long-term nature of investments in restoration, high levels of perceived risks, and difficulties in finding bankable projects with landowner aggregation. To overcome some of these barriers, various practical experiences in public and private finance, policy and monitoring are showing the path to a more sustainable future to make large-scale restoration possible for a more safe and equitable future In this presentation we will introduce the different components of the business innovation ecosystem, we will list the challenges and limitation, and analyze the effectiveness of public incentives in promoting investments in restoration. Here is a summary of challenges:

Challenge 1, Business innovation beyond current markets: How to scale up businesses innovation and investments in Restoration?

Challenge 2, Leveraging the value of mitigation for adaptation: Carbon Markets, How to achieve a fair carbon price for smallholders restoring land? Smallholder certification carbon and ecosystem services

Challenge 3: Governance and livelihoods: Youth participation and addressing tenure conflicts in Indigenous territorial governance, how to improve governance and youth engagement on restoration activities?

Challenge 4: Monitoring and transparency:How to cost-effectively monitor performance and impact of restoration?

Challenge 5: Public Policy Instruments: How to accelerate policies on incentives that either reduce the cost or increase the benefits for farmers?

RENE ZAMORA CRISTALES[1, 2] , Victoria Rachmaninoff[3]

[1] Courtesy Faculty, College of Forestry, Oregon State University, Guatemala

[2] Senior Policy Manager, Initiative 20x20 coordinator, World Resources Institute

[3] Research Analyst, Restoration Policy Global Restoration Initiative, World Resources institute, United States

Tree improvement delivery system: breeding, selection, and seed and seedling production

Seed orchards are the bridge between tree breeding and forest regeneration and the leading supplier of genetically improved seed worldwide. Genetic gain of seed orchards is increasing with the advancement of tree-breeding cycles, and much-accumulated knowledge is available for uptake. Advancements in genomics have also offered insight into how DNA information controls the biological function of forest tree species. Seed orchard management should be fine-tuned accordingly to maximize genetic progress while maintaining sufficient adaptive diversity in forest stands.

The main objective of this session is to facilitate the exchange of research and practice information on the progress of seed orchards functions. Scientific findings for improving seed orchards role as integral component of the tree improvement delivery system will be discussed and shared among participants. This technical session draws together those interested in research and management strategies concerning the genetics and genomics of forest tree species related to seed orchards, management of seed production, flowering, seed physiology and technology, injuries and protection, economics, seed dormancy, testing and storage; impact on seed orchards, ecosystems on landscapes, and conservation.

Tree improvement delivery system encompasses all aspects of tree breeding starting with phenotypic selection and ending with the production of genetically improved seed and seedling. Additionally, this process is paramount in determining genetic gain and gene diversity tradeoff to ensure attaining maximum genetic gain and diversity in future forests.

This session is intended to highlight the place of orchard-produced seed along the possible spectrum of regeneration materials produced from managed and unmanaged natural populations. In response to the recently pressing issue of climate change, the importance of securing resilient and adapted reproductive material is entering a new phase where seed production along with many factors (e.g., pathology, entomology, ecophysiology, and climate modeling) should be collectively considering, thus expanding scientists and practitioners' responsibilities beyond what was commonly done. We believe that this session will create synergetic opportunities for the successful and secured production of future regeneration material.

Kyu-Suk Kang[1], Yousry A. El-Kassaby[2]

[1] Seoul National University

[2] University of British Columbia

Wildlife use and defaunation in the world's forest - what do we know about its impacts and responses?

The loss of forest fauna has repercussions for a range of Sustainable Develop Goals (SDGs). For instance, SDG 2 on nutrition and zero hunger, SDG 3 on good health and well-being, SDG 13 on climate action [1]. Intact and healthy populations of forest fauna contribute to and supports the ability of forests to contribute to climate change mitigation by storing and sequestering carbon [2, 3]. However, the loss of forest fauna is pervasive across the tropical forest realm [4], driven by direct exploitation and forest degradation [5, 6]. Defaunation has a wide range of negative impacts on forest ecosystems [3, 7] and implications for local communities that rely on forest resources for food [8, 9]. Yet, impacts of defaunation are not well studied or included in forest governance [10, 11]. In this session we invite presentations to share state of the art research on 1) how wildlife use and defaunation affects ecological functions, such as seed dispersal and pollination, 2) how forest degradation contributes to defaunation and, 3) how faunal resources in tropical forests can be used more sustainably.

1. Krause, T. and A. Tilker, *How the loss of forest fauna undermines the achievement of the SDGs.* Ambio, 2021.
2. Malhi, Y., et al., *The role of large wild animals in climate change mitigation and adaptation.* Current Biology, 2022.
3. Bello, C., et al., *Defaunation affects carbon storage in tropical forests.* Science Advances, 2015.
4. Benítez-López, A., et al., *Intact but empty forests? Patterns of hunting-induced mammal defaunation in the tropics.* PLoS biology, 2019.
5. Ingram, D.J., et al., *Wild Meat Is Still on the Menu: Progress in Wild Meat Research, Policy, and Practice from 2002 to 2020.* Annual Review of Environment and Resources, 2021.
6. Gray, T.N.E., et al., *The wildlife snaring crisis: an insidious and pervasive threat to biodiversity in Southeast Asia.* Biodiversity and Conservation, 2018.
7. Gardner, C.J., et al., *Quantifying the impacts of defaunation on natural forest regeneration in a global meta-analysis.* Nature Communications, 2019.
8. Booth, H., et al., *Investigating the risks of removing wild meat from global food systems.* Current Biology, 2021.
9. Nielsen, M.R., et al., *The Importance of Wild Meat in the Global South.* Ecological Economics, 2018.
10. Antunes, A.P., et al., *A conspiracy of silence: Subsistence hunting rights in the Brazilian Amazon.* Land Use Policy, 2019.
11. Krause, T. and R.M. Nielsen, *Not Seeing the Forest for the Trees: The Oversight of Defaunation in REDD+ and Global Forest Governance.* Forests, 2019.

Torsten Krause[1] , Andrew Tilker[2, 3]

[1] Lund University Center for Sustainability Studies, Lund University, Sweden

[2] Re:wild, USA

[3] Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany

Actors and the dynamics of forest management institutions: concepts and cases in the Global South

Forests act as critical safety nets for poor communities around the globe. Yet, as socio-ecological systems, they are subjected to rapid transformation – triggered by the dynamics around forest management institutions. Institutions are the humanly devised constraints that shape the behavior and actions of resource users (North, 1990). Forest management institutions denote the formal (e.g. policies, regulations) and informal (e.g. values, taboos and beliefs) rules which shape the use and management practices of communities. On the basis of source, forest management institutions could be categorized following the endogenous - exogenous dichotomy; the former being community-specific complex and embedded rules, while the latter denotes institutions introduced by the state and international agencies (Yeboah-Assiamah *et al.* 2017; Kimengsi et al. 2022). Recent evidence suggests the need for a power-in-institutions analysis to be prioritized (Kashwan et al. 2019). In the recent past, actors and their power tools on the one hand, and institutions on the other hand, have been fairly separated in the treatise on forest use and management processes (Rahman & Giessen 2017). This separate treatise is further acknowledged by contributors to a recent Special Issue with Forest Policy and Economics (see Kimengsi et al. 2022). Fairly recently, scholars have attempted to 'marry' both perspectives, assuming a power-in-institutions dichotomy. Despite such recent developments, there is knowledge fragmentation with regards to: (1) The way forest management institutions have been conceptualized globally, (2) the actor typologies (exogenous and endogenous) and their power manifestations in forest management institutions, (3) the forest management outcomes linked to the way actors shape and are being shaped by institutions. This panel draws from reviews and empirical cases to explore these interconnected issues through: (a) a (re)conceptualization of endogenous and exogenous institutional change processes, with emphasis on the role of actors, (b) the analysis of different actor typologies (endogenous and exogenous) in the restoration of forest landscapes and medicinal plants management systems, and (c)the empirical analyses of power manifestations in forest management institutions around the globe. Besides drawing from evidence in parts of the global south, the panel also seeks to emphasize on methodological considerations in the actor-cum-institutional analyses.

Jude Kimengsi[1, 2]

[1] Leader: Forest Institutions and International Development (FIID) Research Group, Chair of Tropical and International Forestry, Faculty of Environmental Sciences, Technische Universität Dresden

[2] Associate Professor of Resource and Environmental Geography, University of Bamenda, Cameroon

Carbon and nutrient cycling in urban forests

Urban forests provide key ecosystem services for city dwellers such as regulating the microclimate, removing air pollutants, maintaining urban biodiversity, and benefiting human health. Unlike natural forests, urban forests consist of less diverse plant species and are subject to distinctive urban environments and considerable horticultural interventions (e.g., irrigation, pruning, cultivation and fertilization). For instance, urban forests generally receive much higher N deposition than natural forests. The urban heat island effect, high-level atmospheric CO_2 and air pollutant concentrations (e.g., ozone) also have a potential to alter tree growth and biogeochemical cycling in urban forests. This session will focuses on recent research progress in carbon and nutrient cycling in urban forests and their interactions with urban environments, with an emphasis on knowledge exchanges and discussion on the future research directions related to the function, health and management of urban forests.

Enzai Du[1]

[1] Faculty of Geographical Science, Beijing Normal University, China

Climate solutions by the forest sector: Opportunities, challenges, and responses

We propose this plenary session to examine some fundamental questions regarding the role of C sequestration and storage the global forest sector has played in the past and the potential role it can play in the future. It features two keynote speeches (30 minute each), followed by discussion of three panelists (15 minutes each), with the remaining time to answer questions from the audience (15 minutes).

Scientists estimate that deforestation has caused a net loss of 484 $GtCO_2$ since 1900. However, these estimates do not take into account the substantial investment into fire management, plantations, and replanting since 1950, as well as the effect of carbon fertilization. Using an economic-ecological model of global forests, the 1st speaker will compare the outcome of a deforestation scenario with subsequent forest management with what would have happened if the natural forest in 1900 had not been harvested thereafter. Deforestation plus forest management suggests current forests hold about 94 $GtCO_2$ more in 2010 than they did in 1900, while natural forests would have held an additional 186 $GtCO_2$. Human activities on forestland have therefore caused 92 $GtCO_2$ of net emissions. The effect of manmade land use and land use change is relatively small compared to the GHG emissions from industrial sources, but forests can play a larger role in future efforts to mitigate CO_2 if governments provide an incentive for forest owners. A CO_2 price of $17/ton would lead to an additional 147 $GtCO_2$, and a price of $50/ton would lead to an additional 367 $GtCO_2$ stored in forests. Forests can also provide bioenergy, removing more CO_2 from the atmosphere. Coupled with his view of the forest sector's role in a changed landscape of climate policy, the 2nd speaker will articulate the need for a more balanced research portfolio at different levels of aggregation and offer his regional perspective of forest carbon accounting and assessment for Europe before highlighting the agriculture and forestry chapter in the IPCC 6AR. The panelists will deliberate on the adequacy of the modeling approach, the implications of the findings, and the ways forward in pursuing forest sector M&A actions.

Runsheng Yin[1] , Shashi Kant[2], Sen Wang[3], Peter Degeen[4]

[1] Michigan State University, USA (IUFRO 9.04.00)

[2] University of Toronto, Canada (IUFRO 9.00.00)

[3] Canadian Forest Service, Canada (IUFRO 9.04.00)

[4] The Technische Universität Dresden, Germany (IUFRO 9.04.00)

Closing the forest transition theory – forest restoration policy and practice gap

Forest restoration holds the promise to reduce climate change and contribute to multiple other SDGs. Forest transition theory (FTT) explains empirical regularities of forest cover decline followed by forest cover increase over time and in response to identifiable drivers, in multiple countries, single countries or subregions thereof. FTT, in theory, also explains why forest restoration happened, where it did. It should, therefore, have much relevance for contemporary forest restoration pursuits, like the Bonn Challenge, the One Trillion Tree Initiative, or others. Until date, however, efforts to use FTT to guide forest restoration pursuits have been scant and evidence of its successful use are hard to find. In this session authors will present and debate papers and posters that explore the link between FTT and forest restoration policies, programs, or projects. They include empirical cases that suggest forest restoration concurring with forest transition and thus explaining the latter. They also compare successful implementation of forest restoration where forest transition had been taking place versus unsuccessful efforts to restore forest in locations where forest transition has not yet happened, suggesting causal linkages between successful forest restoration where forest transition is an ongoing process. The empirical cases refer to different scales, including multi-country, single country, sub-national regions, and communal territories. The papers also explore the application of FTT to guide forest restoration pursuits and they aim to expand the theoretical understanding of forest transition, for instance, by incorporating forest restoration policies and practice into FTT, or to include forest restoration polices and practice into theoretical propositions that explain land use land cover change.

Jinlong Liu[1] , Wil De Jong[1, 2], Lingchao Li[3], Lu De[4]

[1] Renmin University of China

[2] IUFRO World Forests, Society and Environment

[3] Beijing Forestry University

[4] Asia Pacific Network for Sustainable Forest Management and Rehabilitation

Communicating and Connecting: Post-pandemic approaches to sharing scientific and traditional forest knowledge to inspire trust, engagement and positive change

How do we communicate forest science and foster knowledge exchange, to ensure we have healthy and resilient forests in 2050? Science communication is benefited by connections, professional, personal, and traditional.

The COVID-19 global pandemic severed some connections, but additionally introduced newer tools and technology that change the scope of our communications. The pandemic also underscored the high value of connection. Today's scientific delivery mechanisms are abundant, ranging from memes and YouTube videos to published papers and systematic reviews. Science misinformation is also more prevalent and can influence public and forest stakeholders perceptions of what is real. What inspiration have we gained through this experience that is helping us pivot to and from hybrid environments into the future of communication?

This session seeks to both engage conference goers through an interactive panel of story-tellers, and also invite and highlight the best practices learned over the last 3 years. We seek to demonstrate new techniques and tools that foster and restore connections via communication and collaboration. We will showcase communications that use emerging technologies, art, multi-directional interactions, co-produced research, and communities of practices. We will highlight new techniques for countering misinformation. We will also seek to showcase tools to help us expand who we work with, and to engage in information exchange with indigenous communities, underserved populations and youth.

Finally, relationships and networks built through knowledge exchange and co-development that provide important feedback between researchers and managers and inform future research inquiry will be shared.

Through the lens of communication, this session seeks to address questions related to how we communicate forest science into the future and the theme of Forests and Society Towards 2050. The field of science translation and communication is evolving into an action-oriented, user-centric approach incorporating the scientific community and knowledgeable stakeholders. Improving science literacy worldwide, and increasing access for knowledge exchange across economic barriers is necessary to advance evidence-based and reliable solutions to forest resiliency and sustainability for land managers and policy writers.

Abstracts should showcase one or more of the following themes: 1) knowledge exchange with indigenous and traditional practitioners; 2) communicating positive forest science in the media; 3) new, unique, or alternative communication techniques; 3) highlights and benefits of living in a virtual communication environment; 4) successful knowledge co-development and/or 5) strategies for disarming misinformation.

Jose Bolanos[1] , Nehalem Clark[2], Jennifer Hayes[3], Nicole Heise[4], Ewa Hermanowicz[5], William Hubbard[6], Sheila Mbiru[7], Yasmeen Sands[8], Amy Waltz[9], Gerda Wolfrum[10]

[1] IUFRO Communications Manager, Costa Rica/Austria

[2] Science Delivery Group Leader, USDA Forest Service Rocky Mountain Research Station, Fort Collins, CO USA

[3] National Sustainable Operations Coordinator, USDA Forest Service USA

[4] Chairwoman and Project Coordinator, Ficus, Lima, Peru

[5] Communications Manager for Europe and CIS, Forest Stewardship Council

[6] Assistant Director and Program Leader, University of Maryland Extension, College Park, MD USA

[7] Head Knowledge Management, Kenya Forestry Research Institute (KEFRI), Nairobi, Kenya

[8] Public Affairs Specialist, USDA Forest Service Pacific Northwest Research Station, Portland, Oregon, USA

[9] Director of Science Delivery, Ecological Restoration Institute, Northern Arizona University, Flagstaff, AZ USA

[10] IUFRO Communications Coordinator, Austria

Conflicts in Forest Settings

Conflicts within forest settings may arise from differing expectations about access to resources and opportunities, goals to be pursued, and indeed if forests should be created or persist (as oppose to other existing and potential land uses). Competition and trade-offs around use and outcomes is particularly poignant to forest settings given the myriad of benefits and activities forests can support e.g. carbon sequestration, flood mitigation, wildlife habitat, recreation, natural resource-based economies, food, and energy production. Not only do these possibilities raise questions about *for what* and *by whom* should forests and related resources be managed, but also *how* management should be carried out.

Disputes and conflicts arising from divergent expectations and opinions on such issues – and dissatisfaction with the power dynamics which determine management approaches – may lead to disenfranchisement, threats, violence, abuses of human rights, destruction of property, as well as high monetary costs. Even within democratic and respectful settings, conflicting attitudes can result in inertia, whereby no decisions or actions can be agreed or progressed. Allowed to propagate and persist, conflicts can thus serve as an impediment to sustainable forest management.

This session will encourage exploration and analysis of specific disputes, programs, policies and regulatory frameworks relating to forests and associated resources and opportunities. Contributions may be in the form of empirical studies or theoretical/conceptual models – e.g. examining varying views and norms among forest stakeholders or highlighting conflict management frameworks which have or could be applied to forest conflicts. Through such contributions and discussions, the session aims to explore the causes, impacts, and solutions to forest conflicts so that they may be better understood, mitigated, resolved or otherwise managed so as to avoid or minimise the aforementioned issues.

Mike Dunn[1] , Rebecca Ford[2], Christian Gamborg[3]

[1] Forest Research, UK

[2] University of Melbourne, Australia

[3] University of Copenhagen, Denmark

Digital transformation in forest governance – the Good, the Bad and the Ugly

Digital developments in communication and data collection are currently transforming forest governance. In this session, we discuss how digital technologies may alter power relations and influence forest governance outcomes. Digital technologies are often seen as enablers of a 'sustainable society' and an 'innovative bio-economy'. They are expected to enhance the efficiency of forest value chains, nudge forest owners towards more sustainable practices, and to increase the transparency of forest agencies. Digital communication (i.e., social media) may empower stakeholders and allow for deliberation. Digitally-enabled citizen science can expand and support the monitoring of forests and the environment. Overall, there is a general optimistic sentiment that digital technologies improve forest governance on a micro and macro level.

Yet no technology or medium is ever value-free, impartial, or fully democratic. Through their design and structure, technologies influence practices and policies, ultimately changing our relationship with the environment and our perceptions of environmental and climate emergencies. For example, social media algorithms are biased by design and may further polarize opinions related to forest management. Despite the many merits of public engagement in forest management and policy, there is still ample room for improving how we are communicating and negotiating about forests.

We currently lack systematic knowledge on how digitalization, through new forms of data, surveillance, and negotiation platforms, is changing forest governance. This session takes a critical perspective and discusses the potential opportunities and challenges induced by the digitalization of forest governance. The underlying question is who is benefitting from the digitalization of forests and who is losing, and in what ways? Together we will explore how digitalization may help us or eliminate obstacles in governing forests toward a sustainable and just future. We encourage presentations, posters and flashtalks that broadly address one or several of the following questions:

- How is digitalization (re)constructing forests?
- How do changed perceptions of forests due to digitalization influence forest governance?
- Is digital communication changing established patterns of discursive power?
- In what ways can digitalization facilitate or obstruct pathways towards just and sustainable future forests?

Ida Wallin[1] , Alex Giurca[2], Philipp Mack[3], Peter Edwards[4]

[1] Department of Rural and Urban Development, Swedish University of Agricultural Sciences

[2] European Forest Institute

[3] Chair for Forest and Environmental Policy, University of Freiburg

[4] Landscape, Policy & Governance, Manaaki Whenua - Landcare Research

Effects and effectiveness of forest policies in developing tropical statehoods

Multiple policies and programs are currently deployed to reduce and even halt tropical deforestation. A main challenge is to select, develop and implement effective policy instruments also considering the economic and social needs of multiple user groups. Policies and policy instruments need to be aware of the complex interests, beliefs and power dynamics of sub-national, national and international stakeholders including producer and consumer countries. Traditionally, land use has been regulated through command and control interventions like land use zoning, protected areas, and rules for resource utilization e.g. through sustainable forest management. In addition, informational instruments including e.g. planning and inventory tools, education, capacity building and research need to be considered. More recently, coalitions of public and private actors have designed market-based and demand-driven policy instruments like compensation mechanisms, supply chain initiatives, moratoria and certification. Studies on the effectiveness of such policy instruments and on the related policy formulation and policymaking processes remain challenging and are needed. They need to consider that the potential of policy instruments does not lie in isolated applications but in their contribution to constantly developing policy mixes. These mixes usually have emerged over time in specific country contexts and understanding their functioning, design and effectiveness is even more complex and urgent as compared to single instruments and programs. This session provides an urgently needed platform for exchange, stock taking, further development and communication of related results from forest policy science.

The session invites and presents contributions that

- refer to and rely on current theories relevant for forest policy in the tropics, including values and beliefs, power, forest governance, social network theory, common pools ...etc.
- preferably employ mixed method approaches that combine the deep procedural understanding of qualitative research with stochastic and reproducible quantitative designs that allow for generalization of the results.
- present results on the effectiveness of policy instruments and policy instrument mixes for conservation and sustainable management of tropical forests and related improved livelihoods. Effects can have ecological, economic and social dimensions.
- provide for a transfer of scientific results into policy formulation and policymaking processes at landscape/jurisdictional, national and/or international scales.
- offer either broader overviews based on reviews or illustrate policy dynamics with relevant deep dives from single case studies.

The session includes

- 1 keynote (15')
- 5 oral presentations (10')
- 8 poster short presentations (3 slides in 3')
- room for discussion between the presentations
- space for classical "paper posters" depending on the venue facilities

Richard Fischer[1] , Lukas Giessen[2, 3], Ahmad Maryudi[4, 5]

[1] Thünen Institute of Forestry, Thünen Institute, Germany

[2] Chair of Tropical and International Forestry, Technical University of Dresden, Germany

[3] Coordinator IUFRO Division 9.05 Forest Policy and Governance

[4] Chair of Sebijak Institute of Faculty of Forestry, Gadjah Mada University, Indonesia

[5] Deputy Coordinator IUFRO Division 9. Forest Policy and Economics

Evaluating policy outcomes in complex land-use systems

Forest policies that support sustainable development goals face multiple governance challenges. Forests are a highly important ecosystems with a fundamental role for biodiversity conservation, climate change mitigation, and people's wellbeing. The transition from fossil to biofuels, and, at the same time, safe-guarding ecological life-support systems requires both using and protecting forests. This poses a dilemma in which multiple effects, substantial trade-offs, and a plenitude of legitimate interests need to be balanced.

Coordinated efforts, polycentric governance, and mixes of multiple policies are needed to halt deforestation and advance sustainable forest management. Often, multiple ownership and tenure regimes overlap in multi-level governance systems. Forest ecosystems have different ecological production functions and thus different trade-offs in different world regions. In this session we intend to cover multiple continents as well as different methodological approaches to account to showcase different approaches to providing credible and relevant decision support.

We explore approaches to capture the complexity of forest governance decisions, with a particular emphasis on the policies that address trade-offs on both supply and demand side. The goal is to provide a state-of-the-art overview of research on the governance of complex forest systems. As such research intends to provide decision support, this technical session brings together scholars from multiple disciplines to engage with practitioners.

We will consider how well complexity is captured to assess trade-offs accurately such that the models can be trusted, as well as how accessible the results are such that relevant decision support can be provided. Ultimately, we invite contributions addressing leverage points that may facilitate sustainability transformations. We will have a joint closing panel to collect reflections upon how research on governance of complex systems may provide insights into identifying leverage points.

Thereby, this session addresses three major points: 1) how to capture trade-offs in complex forest management decision and governance problems, 2) how to provide credible and relevant decision support, and 3) how to identify leverage points strategic interventions that facilitate sustainability transformations.

Nils Droste[1] , Dalia D'Amato[2], Marianne Thomsen[3], Wilhelm May[1], Sonny Mumbunan[4], Lukas Giessen[5]

[1] Lund University

[2] Helsinki University

[3] Copenhagen University

[4] World Resource Institute

[5] Technical University Dresden

Finding paths in everyday forest negotiations – towards sustainability and justice in climate transitions

Climate transitions in forests happen on the ground, in particular places and in the everyday lives of people. The session focuses on the vital role of local forest and rural politics in enabling just and sustainable climate transitions. Not all transitions may be just and conflicts often arise. Transitions can entrench inequalities or produce new ones and become unsustainable causing further inequalities in relation to forest access and use. Research indicates that everyday negotiations provide opportunities for finding compromises and synergies among actors. Dimensions of power such as gender, class, residence (urban and rural) or ethnicity organize social relations and affect negotiations and decisions processes as actors may draw on existing institutions or subvert them to reach their aims. To transition to a just and sustainable society where climate concerns are recognized and acted upon, we need to build on and better understand everyday forest politics and negotiations, and how institutions contribute to such a development both locally and across scale.

We call for work that include presentations of cases where citizens act and mobilize various means and tools, to influence decision-making arenas in relation to forests and its implications for climate transitions. The roundtable, posters and flashtalks will discuss contexts and conditions across the Global North and South and aims to bring a decolonial lens on to wider power relations and the geopolitics of forest relations across these various geographies.

Presentations can focus on one or more of the following questions related to climate transitions in forests:

- What are possible openings to achieve social justice and climate transitions in everyday forest relations in different contexts?
- How are climate transitions understood in relation to forests and their management among different groups of actors and how are trade-offs and synergies achieved in different contexts?
- What relations and tools (including digital) do different groups draw upon in different contexts?
- How do dimensions of power such as gender, class, residence (urban and rural) or ethnicity organize social relations and affect negotiations and decisions?

Seema Arora-Jonsson[1], Emil Planting Mollaoglu[1], Manju Menon[2], Kanchi Kohli[2]

[1] Swedish University of Agricultural Sciences

[2] Centre for Policy Research

Forest-based care as an innovative pathway to shifting values, uses and governance of forests

Our actions affect the environment significantly, and in return, negative changes in environment deeply impact human health and wellbeing. Contemporary societies' challenges (e.g. urbanisation, technology addiction, non-communicable diseases) lead to loss of social-environmental ties. These phenomena accentuate social and economic inequalities, leading to the hardships for individuals and communities, and demand transformative innovations, with novel, synergistic collaborations across sectors, new business and governance models, policymaking, and stronger institutions to build social-ecological resilience. There is a growing recognition that exposure, contact, interaction, and connection with forests have positive effects on human health and wellbeing. In parallel, there is increasing awareness about the importance of relational values to nature, to support transformative change toward sustainable, responsible, and just societies.

In line with research developments, policy discourses are increasingly promoting various roles of forests, including for human health, especially in the post-pandemic period. On the ground, emerging initiatives operate cross-sectorally, in the fields of rural development, urban/environmental planning, and forest-based tourism. However, these initiatives are yet not properly enabled by markets and public policies. New roles of public, and civic-societal actors are needed, and rights and responsibilities are being assigned, demanding multidisciplinary partnerships. We define these emerging initiatives as "forest-based care": organised interventions in forest areas that embed aspects of healthcare, rehabilitation, disease prevention, social inclusion, wellness, relaxation, education, spirit and inspiration.

Despite the growing interest on forest-based care, few studies focus on its potential in transforming individuals/groups, reinforcing social relations, supporting innovative perspectives and promoting more sustainable use of forest-based environments. Little is known about the forest policy and governance implications, and the innovations that are needed to support these initiatives, to understand how stakeholders from health and forest sectors could collaborate, and what are the possible synergies and conflicts. Studies, such as RESONATE HorizonEurope-funded project, are needed to explore the relation between nature connectedness and community resilience, and the larger social and economic impacts of forest-based care activities.

This session aims at exploring these issues from various perspectives, included: i) theory, practice and trends across the world; ii) potentials of forest-based care in transforming forest use/management policies and practices; iii) challenges and potential of new transdisciplinary and cross-sectoral collaborations between e.g. forest owners/managers, healthcare givers, tourism; iv) policy, governance and innovation implications of the creation, expansion and mainstreaming of forest-based care initiatives; and more. It encompasses three parts: a) introductory oral presentations, b) interactive participatory-guided panel and flash talks; c) posters.

Laura Secco[1, 2] , Angela Moriggi[1], Aynur Mammadova[1], Mathew White[3], Arnulf Hartl[4], Ilaria Doimo[5], Cecil Konijnendijk[6], Tahia Devisscher[7], Todora Rogelja[1], Beatrice Guardini[1], Liviu Amariei[8], Matteo Vegetti[9], Colm O'Driscoll[5], Giulia Corradini[1], Elena Pisani[1], Alessandra Rigo[2], Aisling Rachel Sealy Phelan[2], Mauro Masiero[1, 5], Paola Gatto[1], Davide Pettenella[1]

[1] Department of Territorio e Sistemi Agricolo-Forestali (TESAF), University of Padova, Italy

[2] Doctoral School Land, Environment, Resources and Health (LERH), Dept. TESAF, University of Padova, Italy

[3] Vienna Cognitive Science Hub - University of Vienna, Austria

[4] Institute of Ecomedicine - Paracelsus Medical University Salzburg, Austria

[5] ETIFOR srl, Italy

[6] Nature Based-Solutions Institute, Spain

[7] Department of Forest Resources Management, CIRS, The University of British Columbia, Canada

[8] AstraAcademy and FSC, Italy

[9] Forest bathing qualified guide, Spain/Italy

Forests in Cities: Ecology, management, and silviculture

Forests in cities are greenspaces where (1) trees are the dominant vegetation type, (2) natural regeneration and establishment of woody species can occur and is often the dominant form of woody plant recruitment, (3) there is no regular human- directed maintenance activity or disturbance that limits the establishment of woody species (e.g., mowing). These forests are a critical component of the total urban tree canopy but are often overlooked and typically lack formal management frameworks. One approach to addressing this deficiency may be to borrow from traditional ecological management frameworks and practices (that is, silviculture). Although urban forested natural areas share similarities with non-urban forests, the impacts of urbanization on forest stand dynamics may require modification of these methods and in some cases development of novel silvicultural guidelines.

Forests in cities are experiencing impacts of climate change which are out pacing those felt by surrounding rural forests. As such, advancing our understanding of the ecology and management of these forests may provide critical information that is relevant to the future management of rural forests. In other words, creating forests resilient to climate change in cities may foster resilient rural forest management practices.

In this session we are seeking urban ecologists and managers that focus their work on forests in cities. Areas of particular interest include:

1. Research on the ecological function of these forests and the role they play in ecosystem service provisioning as compared to other greenspaces in cities and rural analogs.
2. Forest management techniques that are being used in cities.
3. Techniques used for mapping and/or inventorying forests in cities.
4. Socio-ecological systems approach to understanding forests in cities.
5. Civic use and engagement focused on urban greenspace management.

The session format will involve a curated list of short presentations followed by an interactive poster session that include topically relevant projects.

Richard Hallett[1] , Max Piana[2]

[1] USDA Forest Service, Northern Research Station, NYC Urban Field Station

[2] USDA Forest Service, Northern Research Station, Springfield, MA

Gender sensitive leadership in research

Issues related to gender continue to present barriers to female-presenting individuals effectively participating in forest management and research. Recent survey efforts among forest entomologist and pathologists suggest that these barriers fall into three specific categories (1. attributes that make forest entomology or forest pathology attractive career options, 2. gender-based challenges faced by respondents, and 3. career-development challenges faced as a parent) and that there are also certain actions that intitutions and organizations can take to alleviate or eliminate these barriers. These results were presented at the IUFRO Division 7 meeting in Lisbon, Portugal with subsequent discussion among speakers and audience members. Discussion participants identified a mentorship program as a major action item that would serve to progress the goals of IUFRO related to gender equity and inclusion. One essential aspect of a mentorship program is properly training and preparing mentors to be sensitive to gender-related issues in research. This session will 1) provide opportunities for potential mentors to learn about creating an inclusive environment for mentees, 2) provide opportunities for early career researchers, and possible mentees, to research and present the information, and 3) to provide a platform for mid- and late-career professionals to share their experiences and give insight into gender issues in forestry research and management.

Jess Hartshorn[1] , Josephine Queffelec[2], Beccy Ganley[3]

[1] Clemson University

[2] Natural Resources Canada

[3] Plant and Food Research, New Zealand

Governing EU's forests: policy narratives, perception and power

The European Commission, the Council of the European Union representing the EU Member States and the European Parliament as the three main EU policymakers have recently decided upon many new forest-related policy targets. For example, the European Green Deal asks for no net GHG emissions by 2050 and decoupling economic growth from resource use while leaving no one behind, the EU Forest Strategy to 2030 highlights forest biodiversity protection, increased forest resilience and carbon storage while supporting a forest-based bioeconomy. The EU Renewable Energy Directive proposes a target increase for more bioenergy, while at the same time the EU Biodiversity Strategy to 2030 suggests protecting 30% of EU's land, including 10% of strict protected areas also in forests and to plant 3 billion trees in line with biodiversity standards and the EU nature restoration law aims to restore 20% of EU (forest) land by 2030. Conflicts and diverging paradigmatic views on how and by whom forests are to be governed lead to calls for strengthening EU forest-related policy coherence and coordination. This is not only during decision-making itself, but also in the implementation process where increased institutional complexity and trade-offs between targets are to be dealt with. While forests themselves are increasingly under threat in view of the climate and biodiversity crises, societal demands for protection of forest biodiversity clash with using wood for long-term carbon storage, energy purposes and generating new and fossil-free materials.

The technical session therefore asks the following questions:

- What is the "new and politicized" role of forests in the European Union policy-making process? Which narratives and frames are prevailing alongside forests while others are lost in transition?
- How are forests perceived both in the EU institutions, member states and by society?
- What role does power play with the increasing institutional complexity and diverging actors perception in governing EU forests?
- What trade-offs and synergies exist between forest policies across sectors (e.g., forestry, biodiversity, climate, bioenergy) and levels (EU, national, local), and why?

Helga Pülzl[1] , Metodi Sotirov[2], Georg Winkel[3]

[1] Policy Support Facility, European Forest Institute, FI

[2] Chair of Forest and Environmental Policy, University of Freiburg, DE

[3] Chair of Forest and Nature Conservation, Wageningen University & Research, NL

Healing Power of Nature: Forest Therapy in Action

Since the distant past, forests have supported human survival and well-being from many aspects. Besides tangible products, the gorgeousness of natural world attracts people to walk outside, breath fresh air, or listen to the sound of nature. Although present societies are more urbanized, the pull towards natural places has never faded away, and the interest on researching the interconnections between forests and human well-being has increased remarkably over the last decades. So has the exploration on best implementation practice. In particular, forest therapy, as a nature-based healing intervention and also a multidisciplinary research area, is gaining momentum globally among scientists, policy-makers, practitioners, and the public.

Forest therapy has emerged as an accessible and reliable means to alleviate physiological and psychological conditions. Numerous researches have provided extensive scientific evidences suggesting that forest therapy can boost immune functions, improve cardiovascular and respiratory health, assist attention restoration, and lessen stress and depression. Specifically, some recent studies have applied forest therapy as a key approach to reduce pandemic-related anxieties. As an interdisciplinary field, forest therapy research also requires close collaboration among experts from forestry, human health, sociology, psychology, ecology, and others.

In addition to research, since its origin in Japan as "*Shinrin-youku*" in the 1982, forest therapy practice has been advancing in countries all over the world, and policies are developing to advance its application in many areas of individual life. For instance, the Korea Forest Service has been creating and operating therapeutic forests in Korea since 2009, with 1.8 million visitors in 2019. Focalizing on relational forest therapy, the Association of Nature & Forest Therapy (ANFT) has been offering forest therapy guide training since 2012. In Latin America, the Bogotá Botanical Garden has been seeking to reconnect citizens with nature by forest therapies. Despite those great efforts, forest therapy is still in the early stages of its development and implementation. Ongoing dialogues on its integration into public health systems, accreditation, governance, training and education are crucial for moving forest therapy forward.

This session will be dedicated to discussing the most recent research on forest therapy, including physical and mental benefits derived from forest therapy, how it can facilitate connection to nature, as well as the latest applicable technology. Another key focus of the session will be on exploring best and novel practices for implementing forest therapy, including lessons learned from existing schemes, and financial and practical facets of regulating forest therapy initiatives.

Won Sop Shin[1] , Guangyu Wang[2], Michiko Martin[3], Chang Jae Lee[4], Tamberly Conway[5]

[1] Korean Forest Therapy Forum, Korea

[2] UBC Multidisciplinary Institute of Natural Therapy (MINT), Faculty of Forestry, University of British Columbia (UBC), Canada

[3] US Forest Service

[4] Korean Forest Welfare Institute

[5] Conservation Conexions

How to reconcile poverty alleviation with forest integrity in tropical dry forests: ecological research gaps and paradigm shifts for sustainable management

Tropical dry forests (TDF) are under extreme pressure. They are affected by fuel wood extraction, exploitation of high value timber species, grazing and browsing, conversion into agricultural land and are heavily threatened by fires, with an increasing trend attributed to climate change. They cover 0.5 to 1.1 billion hectares, and hold about 25% of the global terrestrial carbon. Worldwide more than 2 billion people depend on wood fuel for their daily cooking and heating. Especially in poor countries and rural areas TDF are an essential basis for livelihoods as source for NTFPs, livestock management, and cash source, mainly from charcoal making. This dependency is a curse and a blessing at the same time. While TDF contribute to alleviate extreme poverty, their unsustainable use increases the risk of ecosystem collapse first, and rural migration and exodus next with all consequences for conservation of biodiversity, climate and soil fertility. Intact nutrient and water fluxes are crucial for prevention of erosion and desertification, especially in an environment under permanent and increasing threat of water scarcity. Many timber species are seriously endangered due to unsustainable logging practices and disturbed natural regeneration processes. Despite of their regional and global relevance, TDF seem to receive less attention in science and society in comparison to humid ecosystems. As a result, they are caught in a spiral of deforestation, fragmentation, degradation, and desertification and thus there is a need to leverage research and action in TDF. In this session we aim to address current and future challenges for science and practice which are rooted in understanding how ongoing trends of deforestation, degradation and climate change affect ecological processes and how science and traditional knowledge can help to adapt to global change. One focus is set on identification of (socio)-ecological research gaps as basis for multipurpose use, increased resilience and restoration. Another emphasis is set on the development of strategies and silvicultural tools for sustainable provision of multiple ecosystem services, including fuel wood, NTFPs, timber, biodiversity conservation, and control of soil and water fluxes. In particular we encourage to submit studies which address a better understanding of how to escape from the unsustainable use trap of TDF which is driven by poverty from all tropical continents. Depending on composition and scope of the presentations we aim to work on a publication in form of a policy-brief or scientific paper as follow up from the congress.

Sven Günter[1, 2] , Natasha Ribeiro[3, 4], Judith Kamoto[4, 5]

[1] Thünen Institute of Forestry, Hamburg, Germany

[2] IUFRO Group, Ecology and Silviculture of Dry Forests in the Tropics

[3] Department of Forest Engineering, Eduardo Mondlane University, Maputo, Mozambique

[4] The Miombo Network

[5] Department of Forestry, Lilongwe University of Agriculture and Natural Resources, Lilongwe, Malawi

Human-Forest Relationship I – Ambiguity in “taking care of the forest”

The attitudes of humans toward forests can be defined as human–forest relationships, combining historical and modern aspects. These relationships affect global, societal, and individual forest-related aims and practices. This session discusses the importance of diverse human–forest relationships for sustainable future societies. Many people feel a strong emotional attachment being affectively connected to forests – they care for and take care of forest. Deep connections between humans and trees are expressed frequently, but often they are highly diverse, even conflictual.

Oftentimes, forests are mainly connected to timber production and rationality, but recently, ‘care’ has been identified as an important element in motivating human action regarding nature. Caring is intertwined with legal and psychological forest ownership. Besides valuing forests for their economic benefit, forest owners express both intergenerational respect and care and attach various meanings to forests as beloved places, a space for psychological shelter or an important part of their identity.

The concept of care (Tronto 1993, 2013) has circulated from feminist theory - originally connected to (domestic) care work in capitalism and gendered power roles - into different disciplinary fields. Currently, glimpses of its potential are making their way into forest-related studies. ‘Care’ encompasses diverse understandings and practices of care taking. It has developed into an “important means of understanding how people relate to the world, and the relationship between people and trees is no exception” (O’Flynn et al. 2021: 228).

Our session contributes to an exploration of the concept’s potential for understanding human–forest relationships. We invite diverse forms of engagement with the concept in relation to forests and their utilization that cover various practices of ‘taking care of the forest’ and/or ‘owning a forest’, their incorporation into culture and their embeddedness in political and institutional structures – be they conceptual or empirically grounded. Central questions for our session are: What does it mean to take care of or to own a forest, in times of climate change and multiple crises? How do people develop and maintain a caring relationship to ‘their’ forest? How is decision-making (in forestry) shaped by relational, social and emotional dimensions? What role do different understandings and practices of care and ownership play in forest conflicts? Do concepts and policies in contexts of bioeconomy, circular economy or biodiversity transform how forests are taken care of? Does a caring relationship towards forests in capitalistic societies remain principally an utopian idea? Or might forests in fact be taking care of humans?

Jana Holz[1] , Jaana Laine[2], Ronja Mikoleit[3, 4]

[1] Institute of Sociology, Friedrich-Schiller-University Jena, Germany, Project “Mentalities in flux” (flumen)

[2] Social Sciences, LUT University, Lappeenranta, Finland

[3] Department of Societal Change of the Forest Research Institute Baden- Württemberg, Germany

[4] Chair of Sustainability Governance, Faculty of Natural Resources, Freiburg University DFG Research Training Group ConFoBi (Conservation of Forest Biodiversity in Multiple-Use Landscapes of Central Europe)

Interactive forest management: Should silviculture and forest operations comply with governance or the opposite?

As forest managers are striving to make forest management comply with criteria of sustainability, they are simultaneously faced with the need to communicate about the rationale of silvicultural practices in the context of sustainability. This includes professional discussions and reporting based on more-or-less on scientific reasoning, but it increasingly also includes communication to and dialogue with a wider group of stakeholders and the general public.

The general public often not understands or misunderstand the technical, or possibly even technocratic, vocabulary we use in forest science and forestry practice. Moreover, governance and sustainability criteria are often not well communicated within the forestry profession. This may lead to inadequate implementation of work instructions, and, in turn, an undesirable result of a forest operation. Deficient communication with stakeholders, or lack thereof, may also result in negative perceptions regarding forestry risks sometimes leading to the loss of social confidence or license to operate.

Depending on cultural context and local traditions, power and equity relations may play a critical role in this process. Furthermore, when indigenous peoples are involved, it is important to take into account the need to conduct consultations in line with national and international regulations on free, prior and informed consent.

The objective of this session is to discuss communication as a tool for implementing forest governance and sustainable forest management. The session will include examples of good and bad communication practices and will discuss how scientists can help contribute to better implementation of sustainable forest management practices and of related forest governance issues.

We welcome presentations covering a wide range of science communication and governance issues. These may include, but are not limited to, issues of trust, regulation compliance, silviculture prescriptions, forest operations, workforce education and training, communication with stakeholders and among forest professionals. These issues may be dealt with at different scales and contexts.

The session will be announced as an open session without pre-determined speakers. We will invite potential speakers to address one or more of the issues outlined above and to present examples that may focus on local, regional, national or even transnational complexities of forest governance or of power and equity in communication relating to forest governance, silviculture and forest operations.

Jens Peter Skovsgaard[1] , Monica Gabay[2], Woodam Chung[3]

[1] Swedish University of Agricultural Sciences, Sweden

[2] DN Gestión Ambiental del Agua y los Ecosistemas Acuáticos, Argentina

[3] Oregon State University, USA

Institutional and Social Innovations in the Forest-based Sector as a Response to Contemporary Challenges

Facing climate change, biodiversity loss, and other challenges, the forest-based sector requires the implementation of sustainable practices to continuously provide to humans a diversified range of ecosystem services. The transition to bioeconomy presumes multi-purpose and sustainable use of natural capital of sustainably managed woodlands and the development and responsible use of social services offered by forests.

Various recent policies, programmes, and initiatives on national and international levels recognize innovation as a mean to drive bioeconomy. Institutional and social innovations are of special interest for the forest-based sector, as both types of innovation are oriented towards the developing of new, or reconfiguring of existing (often rather rigid) rules, organizations, or practices. In the current transition process towards a carbon-neutral and biodiversity-supportive economy, institutional and social innovations can support transformative changes and ensure adequate, societally desired and cross-sectoral responses. Institutional and social innovations are driven in part by societal demand, incorporating societal values and competencies into the innovation process. Therefore, both are considered important tools for responding to wicked problems and improving the living conditions of people (e.g., forest-dependent communities). As such, they become desired or even mandatory outcomes for the implementation of certain social, agricultural, and environmental programmes (i.e., some calls under the New European Bauhaus, European Innovation Programme, Horizon Europe, and Rural Development Programme). Some policy documents (e.g., Forest Strategy) recommend the voluntary involvement of civil society in participatory processes that can lead to adaptive and transformative changes, creating solutions to tackle societal challenges.

In the forest-based sector, research on institutional and social innovation is dominated by case studies addressing various dimensions of innovation processes related to numerous aspects of forest ecosystem services (e.g., their trade-offs, benefit sharing, impacts). The context of case studies varies from tourism, health/well-being, traditional forestry practices to participatory and democratic decision-making and gender initiatives. As scientific thoughts around these types of innovation in the forest-based sector are rapidly developing, new research questions are arising. The proposed technical session plans to address some of them, including: - How does the process of social and institutional innovations roll out on the ground? Whether and how they are differently applied in different regions? What is crucial for the institutionalization and scaling of innovative initiatives in the forest-based sector? How to scale institutional and social innovations to ensure the transition to a more sustainable, green, and just society? How social and institutional innovations can be integrated?

Todora Rogelja[1] , Ivana Zivojinovic[2], Laura Secco[1], Maria Nijnik[3], Simo Sarkki[3], Gerhard Weiss[2], Elaine Parlade[2], Alice Ludvig[2], Mariana Melnykovych[4], Elena Pisani[1]

[1] University of Padova, Department of Land, Environment, Agriculture and Forestry (TESAF), Legnaro (PD), Italy

[2] University of Natural Resources and Life Sciences, BOKU (Vienna)/EFI, Austria

[3] University of Oulu, Faculty of Humanities, History, Culture and Communications Research Group, Oulu, Finland

[4] Bern University of Applied Sciences, School of Agricultural, Forest and Food Sciences, Bern, Switzerland

Managing Safety and Resilience of Forests and Forestry affected by Armed Conflicts and the Climate Crisis: Past and Future Contribution of Forest Science

Armed conflicts constitute a serious threat forests, forestry and foresters as well as rural population near forests in all continents. Direct impacts of armed conflicts include physical damage of forests by shelling, movements and positioning of heavy military equipment. Indirect impacts include long-term contamination of forests by unexploded ordnance (UXO), land mines and chemical contaminants, which pose high risks to the life and health of foresters and local populations working on or visiting contaminated lands. Contaminated forests and surrounding open-land territories must be mapped, delineated, clearly marked, access prohibited and eventually fenced.

The session will address experiences and solutions for forest management and forest policies during and after wars and other armed conflicts. The contributions will highlight:

- Adaptation of forest management to modern challenges;
- Methods and technologies for identification and mapping of dangerous forests area affected by military conflicts;
- Technologies of demining and rehabilitation of forest landscapes;
- Social and economic aspects of forest management in the zones of armed conflicts;
- Use of remote sensing and geospatial technologies for health, dynamic and productivity monitoring of forests;
- Fire and pest management;
- Prognosis of long-term dynamics of forests affected by climate change and war impact;
- Assessment of impact on ecosystem services for forests in zones of military conflicts.

Sergiy Zibtsev[1] , Johann Georg Goldammer[2]

[1] National University of Life and Environmental Sciences of Ukraine

[2] Global Fire Monitoring Center (GFMC), Max Planck Institute for Chemistry

National perspective of Forest resources policy and governance in countries of Latin America under a sustainable perspective

This group aims to present the current stage and the main advances, challenges, opportunities and perspectives of Forest Policy and Governance for the sustainability of forest resources in Latin American countries.

David Alexandre Buratto[1, 2] , Vitor Afonso Hoeflich[1, 2], Paulo Cezar Gomes Pereira[3], Virginia Morales Olmos[4], MARÍA LAURA QUEVEDO FERNÁNDEZ[5]

[1] Programa de Pós-graduação em Engenharia Florestal - Universidade Federal do Paraná

[2] Departamento de Economia Rural e Extensão - Universidade Federal do Paraná

[3] Universidade Federal Rural da Amazônia

[4] PDU Departamento de Ciencias Económicas - CENUR Noreste - Universidad de la República - Uruguay

[5] Universidade Nacional de Asunción

Nature-climate Solutions: Lessons to move from buzzword to transformative practice in tropical forest landscapes

There is much policy, political, and financial interest in nature-based solutions (NbS) as a transformative solution to the climate change and biodiversity crisis. This transformational potential is not yet fully understood, and what is defined as NbS at the global level does not always match what is implemented on the ground. Approaches to rights and inclusion, private sector roles, links to offset mechanisms, and compliance with climate targets are some of the aspects that if not defined may make key issues for the transformational potential of NbS invisible. This includes the direction of funding flows and who –ultimately– benefits from these activities.

This session will provide an evidence base to engage critically NbS' transformative potential, including lessons for a more equitable and effective implementation. It will combine an introductory critical reflection on the limitations and transformative potential of NbS in tropical forest landscapes, with roundtables on key aspects related to science role in relation to Nbs.

After the opening, as serie of presentations followed by fast talks (3') and posters will bring the evidence and critical reflection on how NbS may became opportunities to promote human well-being, social inclusion, power equality and climate and biodiversity benefits.

This will set the scene for the second half of the session that will be focused investigating two topics:

1) how science can support the integration of communities and stakeholder perspectives and power equality and equity arguments in the conceptualization of NbS approaches.

2) how science can bring solutions to integrate the multiple dimensions of NbS in the complex governance contexts in which they are being designed for and implemented. In particular, how social, environmental, and economic aspects interact and how a fact-based approach can help resolve complex trade-off situations in project design and implementation.

Roundtables with public and presenters will be organized, and presenters will be distributed based on the best fit, if not specified in their proposal.

The session will conclude with a summary of the finding of the roundtables proposed by the moderators. Posters will remain available during the entire session.

Marta Suber[1] , Juan Pablo Sarmiento[1], Stéphane Perrier[2]

[1] CIFOR-ICRAF, Peru

[2] Resilient Landscapes, Brazil

Preserving and improving the integrity and functioning of urban forests in the context of global change

As of 2020, 56% of the world's population live in urban areas, expecting urban trees and urban green to deliver numerous ecosystem services including mitigation of urban heat island effects, reduction of air pollution and energy use, interception of stormwater, provisioning of habitats for wildlife and pollinators. In addition, urban forests as an example of nature-based solutions provide important access to the natural environments along with their aesthetic, recreational, and psychological benefits.

Although growing, our knowledge of the ecology and functioning of urban trees is limited. We lack information on the interactions of urban tree physiology and ecology with the complex urban system characterized by numerous anthropogenic stressors (e.g. soil compaction, mechanical stress, excess irrigation, salinity, air pollution etc.), and on the capacity of trees to acclimate and respond to the changing climate. In the already stressful urban environments, climate change is affecting tree vitality through changes in temperature and frequency in heat waves, soil and atmospheric droughts, and pest and pathogen outbreaks. Moreover, urban forests are increasingly subject to biological invasions by exotic pests and pathogens arriving through communication routes and ports of entry. All these threats may strongly reduce the capacity of urban trees and forests to provide the expected ecosystem services and contribution to human well-being.

Therefore, extensive research is needed to better understand 1) the effects of multiple biotic and abiotic stresses of urban environments on tree functioning; 2) the effects of urban forest composition and fragmentation on their resilience to anthropogenic disturbances; 3) the residents' expectations of the services provided by urban forests; so as 4) to improve the design and management of new urban forests. All this argues for an interdisciplinary approach to urban forest research.

We therefore welcome all contributions to assess the drivers, pressures, impacts on the functioning of urban forests and solutions to address them in the context of global change.

Kaisa Rissanen[1] , Valentina Vitali[2], Hervé Jactel[3], Sreetheran Maruthaveeran[4], Christophe Orazio[5], Bastien Castagneyrol[3]

[1] Département des sciences biologiques, Université du Québec à Montréal, Canada

[2] Swizz Federal Institute for Forest, Snow and Landscape Research WSL, Switzerland

[3] French National Research Institute for Agriculture, Food and Environment INRAE, France

[4] Faculty of Design and Architecture, Universiti Putra Malaysia, Malaysia

[5] European Institute for Planted Forest IEFC, France

Provision of Ecosystem Services from Small-scale Private Forests - Is it viable?

Awareness of the role of forests as essential sites for the provision of ecosystem, amenity and other services is growing worldwide. The spectrum includes (e.g.) carbon sequestration, water quantity and quality control, erosion management, recreation, aesthetics, crime reduction, and temperature moderation in urban centres.

As a rule, it can be assumed that these ecosystem services are of great importance to society, but individual forest owners benefit only rarely or in best case indirectly when providing these ecosystem services.

Econimically, it should be noted that the provision of ecosystem services for the forest owner is at least partially associated with higher expenditures or opportunity costs; in the worst case, both effects occur.

In many regions of the world, small and medium-sized private forests (SSFO) play a significant role. From this it can be deduced that supplying society with these ecosystem services can hardly succeed without the recognition of the role of private forests and the owners.

In this respect, there is a potential conflict between the need to involve SSFO in the provision of these services and the fact that this is economically irrational for the individual forest owner. Thus, in many countries at the political level attempts are currently being made to include private forests in the provision of ecosystem services in different ways. The spectrum ranges from regulatory measures to compensation for any cost effects or even additional income in the sense of payment for these ecosystem-services.

In the proposed session, we will evaluate the perceptions of small-scale forest owners on the potential expenditure and opportunity costs associated with the provision of these services. We will also consider the perspectives of local or other governments, or other players and how they perceive the values and importance of ecosystem and other services. We will also examine which of the instruments are, or could be used and are suitable for providing an impetus for a stronger provision of ecosystem services. In doing so, different social and cultural framework conditions are to be examined, which have an influence on the willingness to provide but also the political acceptance of the use of various (e.g.) political, fiscal, and economic instruments to motivate the owners of SSFO properties.

The Session will be divided in two parts:

1. 4-6 introductory presentations
2. Workshop Setting in which a Root Cause -Analysis / -Mapping (RCA / RCM) for 4 to 6 types of ecosystem services will be carried out.

Dr. Christoph Hartebrodt[1] , Paul Mitchell Banks phD[2], Prof. Paulo de Tarso de Lara Pires[3]

[1] Forest Research Institute Baden-Württemberg (Germany)

[2] University of British Columnia

[3] University de Parana

Public engagement to keep urban trees and communities healthy

Much of the world's populations live in cities where they rely on the services of healthy urban forests. Keeping city trees healthy is critical for mitigating the effects of heat waves and ensuring communities remain resilient to climate change. However, urban forests are often the front-lines against invasive pest introductions and their general presence in the built environment predisposes them to the effects of climate change. Given the density of people in urban environments, there is enormous opportunity for public engagement to monitor and study tree health. This session will highlight many projects and approaches for engaging communities in urban forest health research globally.

Joseph Hulbert[1] , Ana Perez-Sierra[2], Richard Hallett[3], Susan Hester[4]

[1] Puyallup Research and Extension Center, Washington State University, United States

[2] Tree Health Diagnostic and Advisory Service, Forest Research, United Kingdom

[3] Northern Research Station, USDA Forest Service, United States

[4] Centre of Excellence for Biosecurity Risk Analysis, University of Melbourne; UNE Business School, University of New England, Australia

Questioning Urban Forest Canopy Cover Goals - Best Practices for Setting and Achieving Canopy Cover Targets

Tree canopy cover (TCC) is the total area of tree crowns projected onto the ground. It expresses canopy area as a percentage of total ground area. TCC is commonly used to describe the amount and horizontal distribution of urban forest canopy within a given city. Tree canopy cover is easily understood by various stakeholders, including government, urban foresters, arborists, planners, urban designers, and developers.

Because tree canopy cover has been linked with ecosystem service provision and benefits for local communities, numerous cities around the world have set targets to increase their urban forest canopy cover. However, these global TCC targets largely appear to be aspirational, rather than being justifiably informed by current research. This panel discussion addresses the topic of urban forest canopy cover targets. A group of international experts will use their personal experiences with canopy cover, as well as knowledge of grey and scientific literature to consider answers to the question of how much tree cover is desirable, or appropriate, in the world's cities.

Early work by panel members confirms that research no longer supports a universal tree canopy cover recommendation. Instead, different canopy cover targets should be tailored to individual cities, based on local context. The international literature also shows that some cities are moving away from setting a single, city-wide, target, opting instead for different targets across electoral wards, local boards, neighbourhoods, or land uses. It's also noted that targets do not preclude cities from aspiring to greater canopy cover, though overly-ambitious targets may be unachievable and undesirable for a variety of reasons. This panel discussion will conclude with recommendations for cities to successfully set and meet canopy cover targets.

Justin Morgenroth[1] , Cynnamon Dobbs[2], Kieron Doick[3], Peter Duinker[4], Rich Hauer[5], Andrew Koeser[6], Lorien Nesbitt[7], Camilo Ordonez Barona[8]

[1] School of Forestry, University of Canterbury, New Zealand

[2] Department of Natural Resources and Environment, University of Connecticut, United States of America

[3] Forest Research, England

[4] School for Resource and Environmental Studies, Dalhousie University, Canada

[5] College of Natural Resources, University of Wisconsin-Stevens Point, United States of America

[6] Gulf Coast Research and Education Center, University of Florida, United States of America

[7] Department of Forest Resources Management, University of British Columbia, Canada

[8] Department of Geography, Geomatics and Environment, University of Toronto Mississauga, Canada

Small-scale, Community, and Indigenous Forestry: Global Challenges and Opportunities

Small-scale, community, and indigenous forestry focus on the interactions between people and forests. In some parts of the world, these terms are related to individuals accessing resources in public or community forests for sustenance and to support their livelihoods. While in other parts of the world, these fields focus on the families and individuals who own forestland and their interactions with the land. Regardless of location, small-scale, community, and indigenous forestry is critical for ensuring the flow of goods and services that society needs.

The importance of small-scale and community forests makes it imperative that we understand the challenges and opportunities these forests, forest owners, and forest users face. In this session we will present a global view of small-scale, community, and indigenous forestry to identify commonalities and differences considering socio-political, economic, and biophysical contexts. In addition to formal presentations, the session will include an interactive, collaborative learning component where participants will be asked to contribute their own ideas on challenges and opportunities faced by small-scale forest owners and community and indigenous forest users via an interactive, digital platform. This will be followed by an open discussion to elucidate trends, highlight the most important findings, and discuss ways for moving forward. In addition, an associated poster session will invite additional presentations on the current state of small-scale, community, and indigenous forestry in specific countries.

The results of this session will have direct implications for people and forests including how people adopt to climate stressors, contributions towards bioeconomies, preservation of biodiversity, and creating more just and equitable access to natural resources.

This session is intended to form the foundation for a forthcoming book on a global review of small-scale, community, and indigenous forestry.

Brett Butler[1] , Mónica Gabay[2], Teppo Hujala[3], Cristina Miranda Beas[4]

[1] U.S. Forest Service, Northern Research Station

[2] National University of San Martin, Argentina

[3] University of Eastern Finland

[4] Pontifical Catholic University of Peru

Towards quantitative explanations of forest governance and its complexity

Forest governance is intrinsically complex, comprising forest use and conservation and dealing with ecological, social and economic issues from multiple levels such as international, national and local. Most land uses, at least in spatial terms, relate to questions of maintaining, removing, or rebuilding forests, leading to cross- and inter- sectorial linkages, with multiple actors and interests over forests resources, which are often in conflict with each other. Hence, forest governance is complex ranging from multiple sectorial, territorial, social and political spheres. Research on forest governance has shown, so far, a methodological divide ranging from qualitative descriptions and explanations towards recent trends on quantitative descriptions. However, there is a lack of research studies on quantitative explanations of forest governance at different levels. Against this background, the objective of this technical session is to discuss methods to quantitatively analyze forest governance and its complexity.

Specifically, the session will deal with questions of how complex interactions among different levels of governance (from the international to the local), different actors (from state bureaucracies to private actors) and different sectors (e.g. forestry, agriculture, trade and environment) shape forest policy and governance. The focus of the session will be on governance structures and their design, understood as the approaches in which forest related issues are addressed and the features along which such structures are developed. In addition it will focus on the detailed politics accompanying these structures on their long journey from formation to multi-level implementation, at times spanning global to local scales and including diverse actors.

Among the aspects to be explored are:

1. Network approaches of complex forest governance systems;
2. Policy instruments and their choices in an increasingly complex context;
3. The establishment of policy issues, venue creation and the role of actors from different governance levels;
4. Inter sectorial coalitions and competition.

Sarah Lilian Burns[1] , Rocio Melina Garcia[2]

[1] Institute of International Forestry and Forest Products, TU Dresden, Germany

[2] Instituto de Investigaciones en Recursos Naturales, Agroecología y Desarrollo Rural, CONICET, Argentina

Tradition in Transition Social and cultural aspects of sustainable forest management in the context of climate challenges

Traditional forest knowledge is an integral component of a network or linkages and relations supported by an overall framework of signs and meanings. It is often based on long historical experiences and deep insights into the dynamic of forest ecosystems. Traditional knowledge is also the source for the traditional use and management of lands, with indigenous practises that care for the earth, without depleting the resources. The theme of the 2019 session of the United Nations Permanent Forum on Indigenous Issues was the generation, transmission and protection of traditional knowledge. It was an opportunity to identify and share good practises and lessons learned to ensure the generation transmission, protection, maintenance and strengthening of traditional knowledge. People throughout the world have interesting traditional resource management systems including protection production and conservation practises that they have validated over time. Integration of indigenous knowledge into contemporary frameworks for conservation and sustainable management of natural resources are now increasingly recognized. More and more the climate movement is recognizant that indigenous knowledge on climate change mitigation and adaptation can benefit the world. Indigenous peoples have the knowledge and practises needed for the global community to implement and scale up climate actions. It is highly demanded to recognize the multifaceted role of indigenous knowledge and practises in stewarding the environment and combatting climate change and its impact. The local people are excellent observers and interpreters of change in the environment. The collective held knowledge offers valuable insights complementing scientific data with chronologic and landscape-specific precision and detail that is critical for verifying climate models and evaluating climate change scenarios developed by scientists at much broader spatial and temporal scale. Moreover, indigenous knowledge provides a crucial foundation for community-based adaption and mitigation actions that sustain resilience for social-ecological systems at the interconnected local, regional and global scales. Together, the global community has an opportunity to reorient the way it interacts with nature and build resilience for all through collaborating with and learning from indigenous peoples. The significance and potential of indigenous practises have been strongly recognized by the scientific community as key approaches to developing and implementing countries national climate action plans and National Adaption Plans and the Paris Agreement. Resilience in the face of change is embedded in indigenous knowledge and know-how, diversified resources and livelihoods, social institutions and networks and cultural values and attitudes.

Elisabeth Johann[1]

[1] IUFRO WG 9.03.02

Urban green against air pollution and climate change

Global warming and ambient air pollution are two major concerns affecting life quality, human health and citizen well-being. The urban environment is characterized by higher emissions of greenhouse gases and air pollutants. More than 70% of the total emissions of anthropogenic carbon dioxide (CO_2) are released in cities, and ground-level ozone (O_3), particles with an aerodynamic diameter lower than 2.5 µm ($PM_{2.5}$), and nitrogen dioxide (NO_2) are the most harmful air pollutants for human health.

Degraded air quality, urban heat island, and biodiversity loss are major problems currently affecting cities. Urban trees are fundamental elements of urban ecosystems, and help meeting clean air standards, sequestering carbon, reducing urban heat island, enhancing biodiversity, and improving citizens' health. Re-greening the cities is seen as a win-win strategy co-benefitting air quality and climate, and a mitigation and adaptation strategy in the context of climate change. However, municipalities and city planners need a suitable selection of tree species for greening strategies to maximize their benefits and minimize their disservices (e.g., release of biogenic volatile organic compounds leading to surface O_3 formation) as well as a quantitative assessment of the capacity of urban trees to remove air pollutants, and to reduce air temperature. The potential of urban trees to mitigate air pollution is well documented by field measurements and model estimates.

The session aims to 1) promote science-based greening strategies for air pollution and climate change governance in cities; 2) propose recommendations and best practices to develop ambitious Urban Greening Plans to create cities-for-healthy-people and pollinator-friendly urban environments; and 3) quantify the environmental (e.g., air pollution removal capacity; mitigation of urban heat island) and health benefits (e.g., reduction of premature deaths) provided by green spaces restoration or improvement.

Pierre Sicard[1] , Wendy Yan Chen[2], Evgenios Agathokleous[3], Marisa Domingos[4]

[1] ARGANS (France), Deputy coordinator IUFRO Unit 8.04.00 "Impacts of air pollution and climate change on forest ecosystems"

[2] University of Hong-Kong (Hong-Kong), Deputy coordinator IUFRO Unit 6.07.00 "Urban forestry"

[3] NUIST (China), Coordinator IUFRO RG 8.04.05 "Ground-level ozone"

[4] Institute of Botany (Brazil), Deputy IUFRO RG 8.04.05 "Ground-level ozone"

Urban trees & green landscapes: Monitoring and management for providing multiple services

Trees and green spaces are integral components of ecosystems of the urban environment that contribute to enhanced environmental quality, quality of life and sustainable development. Scientific studies in the last two decades have emphasized the crucial necessity of green areas within urban socio-ecological systems for ameliorating city-life. The role of urban parks and trees and of roadside trees in different patterns has become much more important in view of the ever-increasing population of cities across the globe. Trees have various specific functions and provide environmental and social services, biodiversity protection, carbon storage and are the raw material for a number of tangible products. They remove particulate matter and sequester carbon.

Trees are ecologically relevant particularly in the urban contexts where land use is intensive and not primarily tree-focused. Topics included in this session are: modeling the relationship between green areas and biophysical and socio-economic variables; assessment and description of spatial structures to manage urban green spaces; vegetation structure and development for informed planning of green spaces; status of tree composition, structure and diversity in different urban neighborhoods; influence of temperature and traffic pollution on urban trees; tree pattern and composition; spatial pattern analyses of land uses and their development over time; urban tree risk management; advanced remote sensing and terrestrial laser scanning techniques for measuring and monitoring urban trees and green landscapes.

VP Tewari[1] , Sreetheran Maruthaveeran[2], Sheila Ward[3]

[1] President, International Society of Tropical Foresters India Chapter, Lucknow, India

[2] Department of Landscape Architecture, Universiti Putra Malaysia, Malaysia

[3] International Society of Tropical Foresters, Puerto Rico

Valuation of water and biodiversity co-benefits in carbon forestry schemes

There is considerable interest in using forest-based mitigation activities as a means of meeting emissions reduction targets. This can be via reforestation or afforestation, avoided deforestation, or changing the stores of carbon within existing forests. Many countries have land-based mitigation activities in their national targets and there is considerable investment interest from business. Carbon markets and payment systems are in an advanced state of development.

There is also much discussion around valuing the co-benefits of mitigation such as for water and biodiversity. With the likely level of investment in forest-based mitigation, there is considerable potential to enact landscape level changes in water and biodiversity management. This could result in the restoration of watershed function or protection of threatened biodiversity. Conversely, bad design could result in perverse water and biodiversity outcomes. For water and biodiversity the methods of measurement and determining payment are less advanced.

Successful carbon+water + biodiversity projects will help meet several SDGs. Moreover, they will contribute to the goals of three UN Conventions (UNFCCC, CBD, UNCCD).

This session will explore how forest carbon mitigation schemes are accounting for changes in water and biodiversity. This will be in terms of how these co-benefits are measured and valued in the schemes, with particular emphasis on what has been learnt, and the main technical challenges. It will thus provide insights for other regions where there is interest in using forest based carbon mitigation schemes to achieve multiple environmental outcomes. Carbon mitigation activities will occur in a changing climate, and presenters will be asked to consider the likely impacts of climate change on forests on the efficacy of carbon mitigation and delivery of co-benefits.

Richard Harper[1] , Rod Keenan[2]

[1] Murdoch University, Australia

[2] The University of Melbourne, Australia

Ways of knowing about multiverse of human-forest relationships: methodological approaches for sustainable futures for the forests

Currently, there exist plenty of societal debates and conflicts related to forests and their utilization. In our pursuit for sustainable forestry, novel forest relationships and practices, we need to realize that we have alternative pathways to be chosen. Pathways that lead towards various futures, are influenced by our current actions and choices, stemming from our relationships with forests. To be conscious about different innovative pathways, and futures they lead, we need a more holistic understanding of the forests and human relationships with them. Human–forest relationships (HFR) affect global, societal, and individual forest-related aims and practices, and they carry historical and modern values towards forests. This relatively new perspective of studying forests, calls for a versatile new way of knowing and studying forests and our interactions with them. This sets us into a quest for new, inclusive and future-oriented approaches for capturing knowledge on experiences, histories, cultures, and societies relating with forests. Here, we can include new applications of more traditional methodologies based on forest and natural sciences but also ideally combine them with approaches from social sciences and humanities, thus creating new, more innovative ways of exploring.

In this session, we introduce different methodological viewpoints of studying human–forest relationships from future oriented perspectives and by introducing new methodological approaches into discussion through short talks by invited experts. Expert talks are followed by facilitated roundtable discussions to co-develop emerging methodological approaches with conference participants. We invite participants from different disciplinary backgrounds who are interested in new, innovative, future-oriented ways of knowing about forests and human interactions with them. We offer conference participants also possibility to submit a poster related to the session theme, however, participants can also take part of roundtable discussions without posters. Discussion of various methodological approaches from different disciplines enables us as researchers to reflect critically on our own methodological traditions, refine traditions to be more advantageous for future-oriented forest related studies, and explore new methodologies. This inclusive discussion, co-development and learning process regarding the different approaches from various methodological backgrounds can produce new types of forest-related research with innovative research approaches and novel outcomes, supporting more sustainable futures for forests and their utilization.

Eeva-Lotta Apajalahti[1, 2] , Annukka Näyhä[2, 3, 4], Maija Halonen[2, 5], Tuulikki Halla[2, 6], Terhi Ek[2, 7], Eeva Houtbeckers[2, 8]

[1] Energy Technology, School of Energy Systems, LUT University, Finland

[2] Human-Forest Relationship Research Club and Network, The Finnish Society of Forest Science

[3] Jyväskylä University School of Business and Economics, University of Jyväskylä, Finland

[4] School of Resource Wisdom, University of Jyväskylä, Finland

[5] Department of Geographical and Historical Studies, University of Eastern Finland, Finland

[6] School of Forest Sciences, Doctoral Programme in Forests and Bioresources, University of Eastern Finland, Finland

[7] Finnish Institute for Educational Research, University of Jyväskylä, Finland

[8] Untame research collective, Finland

Work and employment in the forest sector: challenges and opportunities

Work and employment generated in the forest sector continue to be essential contributors to improvements in livelihoods and the well-being of people, especially in rural areas across the globe. Promoting decent work opportunities and creating quality jobs are critical components of ensuring sustainable and productive forestry operations and achieving a just transition towards more sustainable societies. Decent work deficits, such as persisting informality and poor and unsafe working conditions, remain prevalent in the forest sector, impairing employment quality and sectoral development. Further challenges relate to gender inequalities and the relatively high share of subsistence and seasonal workforce. Many workers in forest-related occupations, notably in developing countries, are vulnerable to discrimination and exposed to poor and unsafe working conditions while suffering from social and economic insecurity. In addition, economic uncertainty caused by crises such as climate change, the COVID-19 pandemic, and other crises may exacerbate decent work deficits, particularly among workers in the most disadvantaged situations, such as individuals in insecure forms of work, migrant workers, and indigenous and tribal peoples. In this context, research needs to collect information, analyse and assess the state of forest-based work and employment before drawing conclusions, providing results and guidance for effective policies and good practices for increasing decent work opportunities while enhancing sustainable outcomes.

The session aims to bring together experts from academia, private and public sectors to discuss recent findings and good practice examples regarding methodological approaches for employment-related data collection and analyses and on more qualitative aspects of labour issues in the forest sector. The session will foster dialogue and exchange of ideas among interested parties, offering opportunities for further research collaboration. Particular attention is given to the following topics:

1. Data and data collection methods measuring forest-related workforce, decent work and job quality indicators
2. Informality and pathways to a just transition
3. Rights at work with a special emphasis on women and gender inequalities in forest-related work
4. Impacts of working conditions on workers' well-being and the effectiveness of OSH infrastructure, policies and legislation
5. Employment generation through social forestry programs
6. Green job opportunities in rural areas
7. Education and training required for the future workforce
8. Impacts of the policymaking on work and employment

We encourage empirical, theoretical and review contributions on the aforementioned topics for oral and poster presentations, flash talks and a panel discussion. The organiser is planning to invite the selected abstracts for publication in a special issue of a peer-reviewed journal.

Rattiya Lippe[1] , Emilin Joma da Silva[1], Waltteri Katajamaki[2], Vera Steinberg[3], Sven Walter[4], Jörg Schweinle[1], Yonca Gurbuzer[4], Qiang Ma[4], Thomas Haussmann[3]

[1] Thünen Institue of Forestry

[2] International Labour Organization (ILO)

[3] FOREST EUROPE

[4] Food and Agriculture Organization (FAO)

Artificial Intelligence in Forest Biometry: from predictions to understanding

Artificial intelligence (AI) encompasses a wide range of techniques and frameworks dating back to the mid twenty century. The use of AI in forestry is relatively new, especially when compared to the early adoption of AI in other fields such as agriculture. In forest biometry, the irruption of AI spins researchers and practitioners to unfold the analysis of complex big data. Narrow AI, defined as an AI system that is specified to perform a limited task, is commonly applied in forest biometry (e.g., analysis of forest structure with 3D point cloud data). Currently, it is possible to efficiently prototype AI algorithms thanks to plenty of publicly available databases, open-source libraries, and the accessibility to computing platforms.

However, the application of AI in forest biometry is mainly focused on improving predictions.Due to the potential power of AI, opportunities are open to broad applications of AI, such as enhancing the understanding of forest processes. Thus, it is important to discuss, jointly with academia and industrial sectors, about the implications, limitations, and capabilities of this technology as an alternative quantitative method.

FELIPE BRAVO[1] , Clara Antón-Fernández[1, 2], Sheng-I Yang[3]

[1] iuFOR , Univeristy of Valladolid (Spain)

[2] NIBIO (Norway)

[3] University of Tennesse (USA)

Artificial Intelligence in Forest Management – Opportunities, Challenges and Social Consequences

The application of artificial intelligence and digitization hold an enormous potential to improve forest policy and planning, and to incorporate ecological as well as economic and social forest values into consideration. The possible advantages of using these technologies stems from an increasing demand from society to better manage the dual objectives of forest policy to both produce valuable forest resources and protect biodiversity and water resources. While there are many *opportunities* associated with the introduction of these technologies, scholar have also identified several *challenges* such as algorithmic bias, unequal access and benefits, cascading failures, trade-offs between for example efficiency and more resilient forests. Hence, it is crucial to gain understanding of how core values of sustainability, are mediated as well as integrated in the use of AI-supported tools in forest policy and planning to be able to assess the *social consequences* of its usage. These consequences could be assessed in terms of the legitimacy, transparency and accountability of the tools but also how it impacts upon the power relations of the actors involved in developing and implementing forest policy and planning.

This interdisciplinary session welcomes speakers from various disciplines with an interest in the role of AI in supporting forest policy and planning. No AI system can be completely transparent or just, and the ethics of AI cannot solely focus on the design of transparent and just systems. Sustainable AI solutions need to consider social, legal, as well as institutional dimensions of AI systems. For instance: How do we think about adapting systems to different societies, contexts, and organizations? How do we create responsible research and innovation that is also aware of different societies, contexts, and organizations? How do we imagine a better future with AI systems?

Presentations covering broad topics/review studies will be prioritized in this session.

Anneli Ågren[1] , Francisco Aguilar[1], William Lidberg[1], Jonne Pohjankukka[2], Petteri Packalen[2], Camilla Sandström[3]

[1] Swedish University of Agricultural Science (SLU)

[2] Natural Resources Institute Finland (LUKE)

[3] Umeå University (UmU)

Assessing forest sustainability through operations research

Forest sustainability is an important topic for society today as forests have been shown to play key roles in mitigating effects of climate change and in meeting multiple demands for goods and services (Theme 1.3). The scales, both temporal and spatial, of options that should be assessed to address these concerns are important, as are the objectives and constraints of the stakeholders and decision-makers. The ability to efficiently assess alternatives through operations research methods seems paramount to informing these conversations. Our understanding of the key performance measures that can be modeled to assess forest sustainability (Theme 2.1) is evolving with advances in basic science and computer systems. A consideration of socio-economic and environmental conditions through operations research methods can allow society to envision the potential outcomes of different solutions for our forests. The integration of socio-economic and environmental values, and the need to assess potential changes in landscapes over long period of time can involve a focus on mosaics of forest patches (Theme 3.3), detail which is continuously becoming available through advances in digital technologies (Theme 5.1) to support assessments of trade-offs in forest management goals. The objective of this technical session is to illustrate advances in operations research methods that allow stakeholders and decision-makers to assess strategies that provide robust forest projections which are of paramount importance to society (Theme 5.2).

Pete Bettinger[1] , Lingbo Dong[2], Jose Borges[3], Rasoul Yousefpour[4]

[1] Warnell School of Forestry and Natural Resources, University of Georgia, United States of America

[2] School of Forestry, Northeast Forestry University, Harbin, Heilongjiang, China

[3] 4.04.04 (Sustainable Forest Management Scheduling)

[4] 4.04.07 (Risk Analysis)

Between synergies and conflicts: public and private forest governance initiatives in the context of turbulent times

An increasing number of disruptive environmental social, and economic events (e.g., extreme wildfires, wars, financial crises) are witnessed globally, thus bringing more attention and commitments to address the climate crisis, biodiversity loss, and the sustainable and multifunctional use of natural resources. Within this context of turbulent times, forests are increasingly referred to as a source of various ecosystem services that are key for human health and wellbeing and pivotal for the sustainability transition. To take a share of responsibility for transitions to a climate-neutral and just society globally, policymakers have introduced strong normative frameworks and policy interventions, and numerous private and market initiatives were and are being developed. However, new and forthcoming policies (e.g., EU Green Deal, SDGs, Bonn Challenge on Forest and Landscape Restoration, New York Declaration on Forests, REDD+, EU Deforestation Regulation, US Forest Act) are bearing contradictory goals with respect to the increase of forest coverage, use of forests, biodiversity protection, and carbon sequestration, and will pose contrasting demands over forest resources, increasing the risks of conflicts over ownership, management, access, and land use rights.

The implementation of the new policy instruments will have significant implications for individuals and organizations, markets and societies, and beyond (e.g., shifting trade patterns, raising inequalities, etc.). If not designed and implemented carefully different policies can have conflicting requirements, as well as among policy instruments and private sector and civil society initiatives. These new policy instruments should also carefully consider their potential impact on small producers, and indigenous and forest-dependent communities, avoiding perverse incentives and replication of the elitist power patterns. Finally, the resource country's stakeholders should be closely engaged in the design and implementation of these instruments, to avoid sentiments of new colonialism, and achieve 'true' participation and deliberation among all relevant actors.

For all these reasons, a 're-concentration' of governance centers and capacities can be expected. But how will those new forest-policy discourses, redistribution of resources, and the emergence of up-to-date technologies, as responses to our turbulent times, impact indigenous communities, forest owners and managers, as well as public bodies and private companies? How the power will be redistributed and will this lead to the transition to a "just, sustainable, and green" society? Through an innovative combination of three parallel roundtables and panel discussions coupled with featured case studies and video interviews, this session gathers worldwide researchers, practitioners, and civil society representatives to answer those questions.

Davide Pettenella[1] , Bas Arts[2], Todora Rogelja[1], Mauro Masiero[1], Aynur Mammadova[1], Laura Secco[1]

[1] University of Padova, Department of Land, Environment, Agriculture and Forestry, Padova, Italy

[2] Wageningen University, Chair of Forest and Nature Conservation Policy, Wageningen, Netherlands

Climate Action in Forest Education

Climate change is one of the most important and complex issues that our society is facing nowadays. Although numerous discussions on climate forums have taken place over more than four decades, on the international arena, concrete action to mitigate and to adapt to the consequences of climate change is still limited and insufficient. Forests are often considered to be the foundation of climate change mitigation. They remove carbon from the atmosphere, reduce temperature through evaporation, regulate water flows, foster biodiversity and much more. The future of our forests will depend on our ability to manage forests in a climate-smart way. However, incorporation of climate change knowledge in the tertiary education curriculum is still highly inadequate, especially in forest education! The gap in well-structured and well-researched educational material is a serious limitation to young forestry professionals - the future managers of our forests. Now, more than ever, we are in need of a competent and well-trained workforce that is well equipped with knowledge and resources to tackle climate change and ensure that our forests are well adapted to mitigate the effects of climate change.

Against this background, this session aims to present experiences and different perspectives on the inclusion of climate education in forest-related curricula and to discuss the possibility of using different innovative alternatives to help complement climate action education for students in forestry and related sciences. Thus, the session aligns with SDG 4 which calls for inclusive and equitable quality education, SDG 13 calling for urgent action to combat climate change and its effects and SDG 17 "partnership for the goals".

Despite the crucial role that forests and forestry play in climate change mitigation, why has the topic of climate action not been addressed by forest education and what will it take to achieve this globally? The keynote speech will address these challenges and open the floor for a discussion between students, youth representatives and education providers to share initiatives, actions and ideas. Students have already taken matters into their own hands to bridge this gap! The session will further highlight the efforts of students to provide complementary content through the IFSA TreE-Learning platform and emphasise the importance of innovative alternatives when it comes to education.

Magdalena Jovanovic[1] , Sandra Rodríguez[2]

[1] International Forestry Students' Association

[2] Joint IUFRO-IFSA Task Force on Forest Education

Continuing Challenges and Novel Solutions: Adapting Growth and Yield Modelling to the Global Change Paradigm

Forest growth and yield modelling has traditionally relied on empirical measurements of past performance to predict future growth. Although climate sensitive modelling, which has long been acknowledged as a necessity for the realities of global change, is not a new idea, empirical, climate insensitive models remain deployed worldwide. Global change threatens to render these models rapidly obsolete, but barriers remain in developing more adaptive replacements. Effective, deployable climate sensitive modelling is hindered by a lack of data and lack of accurate understanding of inter and intra-tree processes. In this session, we invite researchers addressing these problems to discuss approaches and ideas that they have found to overcome these daunting challenges. These might include methodologies which optimize the use of existing data resources, new sources or types of data, new modelling approaches, or other steps that the modelling community can take to improve decision support tools in forestry.

Liam Gilson[1] , Bianca Eskelson[1]

[1] University of British Columbia

Deadwood mapping based on remote sensing – Methods and applications, progress and perspectives

Deadwood is a key forest element of high importance for biodiversity and ecological processes in forests and thus an indicator of forest naturalness. Standing or lying, fresh or in progressive stage of decay, deadwood provides habitat for about 20–25 % of forest species (Herrmann and Bauhus, 2010). In addition, information about deadwood is key for studying tree mortality, forest health, forest disturbances and regeneration processes and to assess risks for human forest use.

Mapping deadwood across large areas is therefore of general interest for various topics in forest research and management. The spatial extent as well as the required detail of deadwood mapping (e.g. standing or lying, at single tree or stand level, in a certain decay stage or of a particular tree species) may vary depending on the focus of the study or application. In general area-wide information is required.

In this respect remote sensing data have an advantage over inventory data, which deliver only local information. Remote sensing offers continuous information with large spatial coverage as well as possibilities for automated and standardized detection of forest structures. This is crucial especially for time series analyses of dynamic forest processes and for planning, monitoring and implementing of recurrent forest management and forest nature conservation measures.

In recent years a multitude of new developments focusing on deadwood detection from remote sensing data emerged. Considering this trend, further rapid progress in remote sensing technologies can be expected. The goal of this session is therefore to:

(1) Give an overview of the novel remote sensing based deadwood mapping methods both for standing and lying deadwood including the use of:

- Different platforms: satellite, aerial and terrestrial remote sensing
- Different sensors: LiDAR, optical data etc.
- Different detection algorithms: machine learning, artificial intelligence
- Different data sources and databases (also open source)

(2) Provide examples of different applications based on deadwood parameters derived from remote sensing e.g. for predicting species' habitats, for the identification of old-growth forests, in analyzing tree mortality or disturbance patterns or in applied forest nature conservation and forest management planning e.g. such as traffic safety monitoring.

(3) Discuss lessons learned and future perspectives regarding the usability of remote sensing data, methods and derived deadwood variables for applications in forest ecology and biodiversity studies as well as in forest management on various scales.

Katarzyna Zielewska-Buettner[1] , Petra Adler[2], Veronika Braunisch[1] , Manuela Hirschmugl[3]

[1] Department Forest Nature Conservation, Forest Research Institute Baden-Württemberg (FVA), Germany

[2] Department Biometry and Informatics, Forest Research Institute Baden-Württemberg (FVA), Germany

[3] Department of Geography and Regional Science, University of Graz and Joanneum Research, Austria

Developments in complex remote sensing-assisted forest surveys to support monitoring and assessment of forest ecosystems

Information on multiple forest benefits such as carbon sequestration based on credible and science-based inventory and monitoring systems is important for attracting and sustaining investments for forests and communities, to sustain the productivity, diversity, and health of forests for present and future generations. Remote sensing data are a core part of an increasing number of forest surveys. The contribution from remote-sensing-based surveys offers opportunities for making cost-efficient and standardised inventories across large areas. The rapid development of remote sensing techniques and the resulting simplicity whereby analysts can assess forest information across large areas have impelled developments in statistical inferential methods for large-scale forest surveys to support the monitoring and assessment of forest ecosystems.

We are interested in mobilizing research and technology to develop credible and easy-to-understand-and-use knowledge systems and platforms that could help researchers and practitioners conduct broad-scale forest inventories. This Session is distinctively conceived to give participants hands-on experiences on remote sensing-assisted forest inventory applications for monitoring and assessing forest ecosystems at large-scale by bringing together scientists to deal with the following targets:

- to review the state-of-the-art on applications of large-scale forest inventory data to derive forest ecosystem service indicators;
- to highlight statistical sampling and estimation advancements, with special reference to coupling ground and remote sensing data and to spatial extrapolation at multiple scales;
- to foster forest inventory research cooperation between countries;
- to provide an opportunity to stimulate the collection of scientific papers on the issues above, to prepare a Special Issue hosted by Silva Fennica, an international peer-reviewed journal.

As members of the research community, we support and promote transparency, openness, and reproducibility of science. We selected Silva Fennica for our Special Issue because it is one of the pioneering journals in forest and wood sciences to apply the Transparency and Openness Promotion (TOP) guidelines. Currently, the journal is going through a multi-level transition, reaching level 2 by 2024. This level will require data, materials, and code openness as a condition for publishing.

Svetlana Saarela[1] , Gherardo Chirici[2], Piermaria Corona[3]

[1] Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences, Norway

[2] Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, Italy

[3] CREA Research Centre for Forestry and Wood, Italy

Digital (soil) mapping as a suitable approach to generate spatial forest site and biodiversity data at different scales

Forest site data are important for the estimation of tree species suitability, silvicultural adaptation measures and possible changes to soil biodiversity under climate change. Forest sites are characterized by various factors. especially soil and humus forms and its physical and chemical characteristics, which are determinants for tree species suitability and tree growth. In forest site science, it was previously assumed that these factors are subject to annual fluctuations, but in principle remain unchanged at least within a forest rotation period of 100 – 150 years. With climate change, this assumption is no longer correct: Seasonal anomalies are accumulating, deviations from long-term means, and an increase in climate extremes, such as drought are observed and require a re-thinking of classical concepts of forest site classification, mapping and in assessing soil biodiversity.

While pedo- and hydropedological information at the plot or site-scale is often available from standardized inventory or survey programs, data with complete spatial coverage are often inexistent. Terrestrial mapping of such characteristics isn't a suitable approach in most cases due to limited financial and human resources and due to rapidly changing environmental conditions. Therefore digital mapping approaches are getting increasingly popular, also due to the advancing development of such methods in general, but also to the increasing availability of source data and the progressive development of computing power.

State of the art in digital soil mapping is the use of various artificial intelligence methods in the form of machine learning algorithms and deep learning approaches with neural networks.

Digital mapping techniques allow the use of numerous geological, topomorphometric, climatic, hydrological and other auxiliary variables related to soil formation and soil biodiversity. Such predictive datasets are becoming increasingly important with the development of remote sensing techniques, in particular, datasets on soil moisture or wetness but also on current vegetation cover and vegetation-related indices. In addition, digital elevation models are becoming increasingly detailed. Based on DEMs a wide range of topographical and hydrological indices can be derived and provided for predicting pedological issues.

Furthermore, digital mapping techniques enable prediction of current and future soil-related issues. As global warming progresses, essential spatial datasets may be developed for the adaption of forest management to climate stress or for optimizing carbon offseting. In addition, topic-specific models can be applied to well-surveyed areas and the results subsequently applied to a target area.

Lina Horn[1] , Harald Vacik[2], Michael Englisch[1], Manfred Lexer[2]

[1] Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW)

[2] University of Natural Resources and Life Sciences – Institute of Silviculture, Vienna, Austria

Digitalization for sustainable forest management

Digitalization is currently revolutionizing industries around the globe, from manufacturing to healthcare. Digitalization is characterized by a series of enabling technologies that when applied and connected, fundamentally change the way that we organize society as well as produce goods and services. For the forest sector, digitalization provides a wide array of opportunities and challenges that has the potential to significantly change forest management. In this session we will explore how digitalization can change four key aspects of forest management: forest information, precision forestry, forest operations, and overall sustainability assessment.

Forest information: developments in sensor technologies combined with rapid development of machine learning (ML) techniques gives wide array of opportunities for greatly improved forest information. The session will highlight examples of current research and how emerging sensor technology for 3D point clouds and ML can fundamentally change the available data for data-driven decisions for sustainable forest management.

Precision forestry: better information can enable precision forestry aimed at producing more ecosystem services through silvicultural treatments adapted to the very localized conditions. The session will highlight examples of current research on how improved information and decision support systems can lead to precision management for traditional silvicultural practices such as tree species selection during regeneration as well as planning and implementation of thinning.

Forest operations: the efficiency increase in the forest sector over the past 50 years has been phenomenal and largely driven by mechanical-technical developments such as the transition from hand saws and chainsaws to the current fully mechanized harvesting systems. The current technologies and methods are once again reaching a high degree of maturity and the potential for improved efficiency within the current paradigm can be argued to have come close to saturation. The session will highlight examples of current research and how automation of forest operations may change forest operations in the decades to come and enable cost-efficient precision silvicultural treatments.

Sustainability: digitalization gives opportunities for better information on various sustainability indicators and to implement precision forestry that not only optimizes production both also increases the overall sustainability of forest management. The session will highlight examples of current research on how improved information about biodiversity can be achieved and integrated into sustainable forest management decisions and documentation of sustainability.

The session will include an panel discussion and poster session focused on how digitalization will change forest management and the forest sector in general.

Rasmus Astrup[1] , Juha hyyppä[2], Sverker Danielsson[3]

[1] SmartForest & NIBIO, Norway

[2] UNITE & NLS, Finland

[3] Mistra Digital Forest & Swedish Forest Industries

Disturbance impacts on climate regulating services in forest ecosystems

Forest ecosystems have been in focus of nature-based solutions to mitigate climate change. Forests constitute the largest terrestrial carbon sink and absorb about one-quarter of anthropogenic carbon emissions. The climate-regulating function of forests is not restricted to carbon. While some other services, such as the storage of methane and nitrous dioxide, have a global impact on climate regulation, others, such as albedo and latent heat fluxes, are effective at local or regional scales. The local buffering capacity of extreme weather conditions by intact forests gains increasing importance to protect rural communities, animals, and plants.

Increases in natural disturbance regimes will likely compromise the climate mitigation function of forests. While many investigations have addressed disturbance effects on the forests' carbon balance, comparably little research has addressed other climate regulating services. However, changes in other climate regulating services following disturbance might be regionally even more important than altered carbon dynamics. For instance, some studies predict that positive changes in albedo outweigh negative disturbance effects on carbon in boreal forests. Others indicate an accelerated thaw of permafrost after disturbance, ultimately releasing additional greenhouse gases into the atmosphere. Existing knowledge gaps render high uncertainty of disturbance impacts on the sum of climate regulating services, and hamper the development of robust management strategies to maximize the climate change mitigation function of forests.

This session aims to bridge knowledge gaps about forest disturbance impacts on climate regulating services. Our session will foster a more holistic understanding of forest-climate interactions beyond carbon. The session will address disturbance impacts on multiple climate regulating services in the past, present, and future across forest ecosystems in different continents. We expect up to eight contributions as oral presentations, and welcome additional poster-type presentations. At the end of the session and beyond, we will discuss the session's findings and future directions aiming to encourage future collaborative research addressing disturbance impacts on climate regulating services in forest ecosystems.

Judit Lecina-Diaz[1], Dominik Thom[1]

[1] Technical University of Munich, TUM School of Life Sciences, Ecosystem Dynamics and Forest Management, Germany.

Experimental underpinning for projections of forest futures

The Earth System Models that inform climate policy include treatments of the forest-dominated land carbon sink; as the models run forward in time, their simulations of forest move further and further beyond the model settings over which the simulations have been calibrated and evaluated. While no experiment can mimic exactly the future conditions acting on forests (supposing that the conditions are even precisely known at this point), experiments can provide vital insights that strongly constrain model projections.

Experimental approaches that focus on forest patches (rather than on individual plants) are particularly useful and are the focus of this subplenary session. Patch-scale experiments allow for interactions between individuals, and for food web feedbacks that can radically alter forest dynamics. A new generation of full-scale forest Free-Air CO_2 Enrichment (FACE) facilities is now producing results, as are a range of droughting, heating, water, and nutrient manipulation facilities. We seek submissions from all such patch-scale manipulations across all forest biomes, particularly those targeted at future forest scenarios. We also seek metanalyses of such manipulation experiments that deepen our understanding of general results across forest types, as well as model-data syntheses demonstrating the value of the newly emerging experimental results for climate projection and Net Zero assessments. We recognise that natural experiments (e.g. space-for-time substitution and use of existing gradients), and modelling-only studies (including intercomparisons), will be adequately covered elsewhere in the conference, and so do not target those for this session. Similarly, long-term monitoring of forest sites is enormously valuable but is not the focus of the current session.

Rob MacKenzie[1] , Virginie Baldy[2], Rossella Guerrieri[3]

[1] Birmingham Institute of Forest Research, University of Birmingham, UK

[2] Institut Méditerranéen de Biodiversité et d'Ecologie marine et continentale (IMBE) - Aix Marseille Université, CNRS, France

[3] Dept. Agricultural and Food Sciences, University of Bologna, Italy

Forest without borders: National Forest Inventory Networks and their potential for large scale monitoring and reporting

All National Forest Inventories have been designed primarily to meet national needs concerning the status and trends of the forest ecosystem. However, they serve also as the basis for reporting on trans-national (sub-continental, continental, ecozone, and global) and to international organizations and processes. Many of the national and larger-scale information needs are similar while the use of NFI data for transnational reporting, can be complicated as the definitions as well as methods vary between the countries and regions..

This session will present the development and achievements of multi-national NFI networks, which try to address that problem. It showcases efforts to enhance cooperation and knowledge exchange between countries. The objectives are twofold on the one hand, to assess up to which degree harmonization is possible and, on the other hand, to analyze what level of harmonization is needed to fulfill the demands on at large scale. The session will therefore reveal the potential of NFIs for trans-national reporting.

In order to meet these goals, studies dealing with the comparison of the different assessment methodologies considered by NFIs will be presented , including remote sensing techniques and ground surveys, or the combinations of both. This will include the developments and challenges of the European National Forest Inventory Network (ENFIN), the Latin-American and Caribbean National Forest Inventory Network (Red IFN-LAC), and the North America Forest Commission (COFAN). Other initiatives and countries not involved in Networks will also be invited to participate to share theirknow-how.

Iciar Alberdi[1] , Carla Ramirez[2], Klemens Schadauer[3], Joberto Veloso de Freitas[4], Sonja Oswalt[5], David Morales[6]

[1] Forest Science Institute, National Institute for Agricultural and Food Research and Technology (INIA-CSIC), Spain

[2] National Forest Monitoring, Food and Agriculture Organization of the United Nations (FAO), International Organization

[3] Federal Research Centre for Forests-BFW

[4] Universidade Federal do Amazonas - UFAM

[5] US Forest Service

[6] Food and Agriculture Organization of the United Nations FRA-FAO

Gender and Indigenous Equity in Forestry: Practice, Governance and Education

Gender equality, diversity and inclusion are crucial elements of sustainability transitions, yet rarely and inadequately reflected in the forest sector globally. The forest sector is associated with difficult working conditions, which favor socially dominant groups and able-bodied men, leaving little space for other genders and minorities. Traditional power structures and norms remain despite openings created by new technology and emphasis on employees' higher education and better working conditions. Initiatives and policies supporting increased diversity and inclusion of women, Indigenous peoples, and other non-dominant groups are blossoming, yet have not been able to overcome the persisting inequalities. Ultimately, gender norms, power asymmetries and gender-based bias can perpetuate exclusion of the knowledge, talents, and labor that could benefit the forest sector.

Gender equality and inclusion is instrumental for the development of the sector and for achieving the sustainable development goals, to improve policy and policy implementation, competitiveness, innovation, as well as social and economic considerations. During the past decade, several different forest-related gender equality and diversity initiatives have been developed and implemented across the globe. Interesting examples of forest sector-wide strategies can be found as well as targeted initiatives. Our joint session provides ample examples of such initiatives, research results and educational efforts to improve gender equality in the forest sector under three themes.

We encourage the submission of papers that examine the following themes:

- **Past & Present – Practice in the Tropics:** The practice of women's inclusion and participation in the forest sectors including sub-themes as gender equity and its benefits in land use and ownership; and other related themes. Perspectives of sustainable societies whose nature-based solutions include gender diversity in all stages, from decision-making and planning to implementation and monitoring.
- **Present – Governance and grass-root initiatives:** This theme sets out to explore different initiatives, practices and articulations; their specific and situated outcomes; and the implications for forests, people, power and knowledge. By learning from the community and contextual differences we enhance our understanding of, and recommendations for, gender equality and diversity policy development and implementations.
- **Future – Education for a better future:**: The future of forestry is dependent on a competent workforce with the knowledge and capacities to successfully deal with the pressing issues of the 21st century including the climate crisis, environmental injustice, and inequality. This theme focuses on initiatives and experiences of improving Justice, Equity, Diversity, and Inclusion (JEDI) in forest education worldwide.

Ida Wallin[1] , Todora Rogelja[2], Stephen Wyatt[3], Maureen Reed[4], Barbara Öllerer[5], Theresa Klara Loch[6], Janette Bulkan[7], Ana L. Violato Espada[8], Ana Carolina C. Vieira Vieira[9], Barbara Bomfim[10], Gun Lidestav[1], Alice Ludvig[5], Teppo Hujala[11], Ivana Zivojinovic[5]

[1] Swedish University of Agricultural Sciences

[2] University of Padua

[3] Université de Moncton

[4] University of Saskatchewan

[5] BOKU

[6] University of Freiburg

[7] University of British Columbia

[8] U.S. Forest Service International Programs Brazil

[9] Instituto Beraca

[10] Brazilian Forest Women Network & Lawrence Berkeley National Laboratory

[11] University of Eastern Finland

Global forests in a hotter and drier world: Assessing forest damage and tree mortality from climate change-accelerated insect outbreaks and infectious diseases

Global forest ecosystems are facing unprecedented climate conditions in many parts of the world. Over the last 50 years, observations are accumulating of increasing forest decline and tree mortality following hotter droughts, often caused and accelerated by biotic interactions with damaging insects and infectious diseases. The globalized trade market exacerbates this phenomenon by the displacement of biotic agents across natural barriers to naïve and thus highly vulnerable forest ecosystems. Given the importance that forests play in maintaining global biogeochemical cycles, human livelihood and welfare, and providing essential ecosystem services, a thorough understanding of the current and future states of global forests is badly needed for forest management planning and, at a higher level, for policy decision making. Current assessments of forest damage and decline as well as rates of tree mortality are often of low spatial and temporal resolution and are not available for many regions across the globe, in particular the large forest regions of the Eurasian boreal forest and the tropical forests of South America and Africa.

This session seeks to initiate a joint effort across scientific disciplines and administrative agencies concerned with forest damage assessments. The goal is to stimulate collaborations across regional and national boundaries with the aim to initiate an international (subcontinental to global) spatially-explicit database on forest damage. We welcome contributions from ground-based assessments of forest condition (e.g., national forest inventories) as well as from international initiatives for monitoring tree mortality and forest insects and diseases. Furthermore, we encourage submissions presenting new methodologies for detection and monitoring of biotic forest disturbances, in particular remote sensing approaches, as well as GIS-driven analytical assessments of forest insect and disease epidemiological dynamics.

Deepa Pureswaran[1] , Henrik Hartmann[2]

[1] Canadian Forest Service / Coordinator of WP 07.03.06: Integrated Management of Forest Defoliating Insects of Division 7.00.00 – Forest Health

[2] Max Planck Institute for Biogeochemistry / Coordinator of IUFRO Task Force on monitoring of global tree mortality patterns and trends

IAWA-IUFRO Symposium: Advancing Methods and Applications of Wood Identification

Deforestation represents a massive threat to global biodiversity, with unsustainable and illegal logging, and trade in illegally harvested forest products contributing significantly to continual forest loss. Though various methods are used to identify timber along the forest products supply chain, current global identification capacity cannot meet demand. Despite traditional wood anatomy being the most frequently used method for taxonomic identification, for many taxa it can only achieve genus level identification. On the other hand, quantitative wood anatomy, computerized image analyses (machine learning), genetic methods, near infrared spectroscopy, real time time-of-flight mass spectrometry for wood identification and isotopic analysis to determine provenances are scientifically developed but as-yet not widely deployable technologies. In last decade, with improvement of research capacity in artificial intelligence, biotechnology, phytochemistry and databases establishment, new opportunity for reliable, smart and efficient taxonomic identification and geographical tracing of wood and wood products is open and attracted increasing interest to promote legal timber harvest.

The goal of this IAWA-IUFRO symposium is to present the most recent advances in methods and applications of wood identification for promoting sustainable supply chain of forest products. Specifically, this session will focus on: (1) improving research capacity of wood identification methods; (2) establishing databases and integrating network for wood identification; and (3) providing application adopted with effective technologies and tools for various scenes of wood identification.

Yafang Yin[1, 2, 3] , Gerald Koch[2, 3, 4], Tereza Cristina Monteiro Pastore[2, 3, 5]

[1] Research Institute of Wood Industry, Chinese Academy of Forestry, China

[2] IUFRO Research Group 5.16.00 Wood Identification

[3] International Association of Wood Anatomists (IAWA)

[4] Thünen Institute of Wood Research, Germany

[5] Forest Products Laboratory, Brazilian Forest Service, Brazil

Inclusion of environmental variables and ecological services as part of the decision process in intensive silviculture: lessons from around the world

Forest plantations are a good vehicle for securing current and future timber demands and increasing carbon sequestration needs in coming years. Intensive silviculture allows these plantations to grow at faster rates, increasing yield and revenues while having positive effects to the environment as reservoirs of carbon. At the same time, quantification of environmental impacts of those silvicultural treatments is of paramount importance for ensuring sustainable forestry. The last three decades have seen an explosion in the utilization of modeling tools that relate forest productivity and ecological services with climate and soil variables. In this session we propose to summarize the efforts happening around the world with respect to the utilization of soil and climate attributes to predict stand productivity, silvicultural responses to different treatments and the implication of these in different ecological goods and services. A round table will serve the scientific community to collaboratively discus new trends and ways to move forward given the handful of possible climatic scenarios.

Carlos Gonzalez-Benecke[1] , Cristian Montes[2], Rafael Rubilar[3], Ben Du Toit[4]

[1] Oregon State University

[2] University of Georgia

[3] Universidad de Concepcion, Chile

[4] Stellenbosch University, South Africa

Initiatives and Equity for Forest Education in a New Era

Facing global issues such as climate change, illegal logging, and widespread deforestation, particularly through the COVID-19 pandemic, higher forest education has shifted away from traditional forestry approaches to methods that focus on sustainable forest management (SFM) and environmental conservation. Forestry professionals need to master new technologies to manage natural resources and be capable of creating and implementing effective policies. Meanwhile, to compete with many other popular majors of higher education and attract more excellent students to register for forestry programs, higher forestry education needs to explore more subjects that can integrate frontier research and technology or innovative application into forest-relevant subjects beyond forestry management and operation. The extended education broadens the job markets for students in forestry who can adapt themselves to work or study forward beyond the forestry profession and forest engineering.

On the other hand, with common objectives of sustainable forest management and environmental conservation, forest management strategies however differ among regions with existing gaps. To address gaps in forest management knowledge and the effectiveness of current management strategies, high-quality education resources need to be promoted and shared in the region experiencing unprecedented deforestation, climate change, and general loss of biodiversity.

The project "Innovative Sustainable Forest Management Education in the Asia-Pacific Region" is a good example of promoting initiatives and equity in forest education across the boundaries of regions. Phase I and Phase II of the project have brought eminent forest experts worldwide together and developed 14 graduate-level online SFM courses with great collaborative efforts among APFNet, UBC, and APFECM member universities. The combination of emerging educational technologies, high-quality and relevant content, and online pedagogy generates an improved form of forestry education that shares the most current information on SFM and supports the interaction of peers and professionals without the constraints of geographical location and time. All courses are open education resources has been delivered to over 15,000 learners from over 90 international economies. This project will be moved into Phase III, with continuing efforts in developing and sharing high-quality innovative online forest education worldwide.

After the COVID-19 pandemic, online education has become more popular worldwide. AP-FECM will share the experience in online forest education. Several renowned content experts will share their insights into the development of forest education, platform sharing and integration, faculty and student exchange, and mutual course articulation and recognition, which can enhance the initiatives and equity of forest education in a new era.

Guangyu Wang[1, 2] , Suzy (Xueqin) Zeng[1, 2]

[1] Executive Office, Asia Pacific Forestry Education Coordination Mechanism (AP-FECM), University of British Columbia (UBC), Canada

[2] Faculty of Forestry, University of British Columbia (UBC), Canada

Innovating advisory systems to cope with complex forest governance

Advisory services constitute important forest policy instruments to influence landowners' forest management behaviour through information and advice. A recent systems analysis of extension, advice, and knowledge systems in Europe (Lawrence et al. 2020)[1] reveals large diversity in what they termed Forest Knowledge and Innovation Systems (FOKIS) modelled on the parallel AKIS in agriculture. The make-up of such systems consists of each country's regulatory framework, characteristics of forest owners and service providers, as well as the specific informational tools.

The growing complexity of forest governance is reflected in overarching trends in FOKIS including increasing flexibility, openness and participation of owners as sources of information; increasing reliance on information and persuasion rather than enforced compliance; a shift of attention from timber to a wider range of ecosystem services; a shift of funding and providers from public to private sector; and emergence of new virtual communication tools.

These trends also indicate a need for innovations in advisory services, to adapt to forest owners' evolving needs, tackle emerging policy objectives, diversify service providers, establish novel institutional arrangements, and introduce inclusive mixed-means advisory tools. This session aims to augment systemic understanding of advisory innovations, examining *key actors and their interactions*, including actor's interests and power resources (including gender equality), e.g. how does the innovation affect the trust and equity among the actors; and *impacts and effectiveness*, i.e. how effectively does the innovation influence forest owners' behaviour, what are intended and unintended impacts, what is the performance in comparison with other policy instruments and within a policy mix. In particular, we want to explore the relationship between context, advisory system, and results; explore the role of learning within the system; and identify successes and failures. We see a need to broaden the FOKIS analysis beyond Europe, to include a range of governance systems, and we welcome contributions (both oral and poster presentations) from different countries and continents.

[1] Lawrence, A., Deuffic, P., Hujala, T., Nichiforel, L., Feliciano, D., Jodlowski, K., Lind, T., Marchal, D., Talkkari, A., Teder, M. and Vilkriste, L., 2020. Extension, advice and knowledge systems for private forestry: Understanding diversity and change across Europe. Land Use Policy, 94, 104522. https://doi.org/10.1016/j.landusepol.2020.104522

Vilis Brukas[1] , Antonio Brunori[2], Teppo Hujala[3], Anna Lawrence[4]

[1] Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Sweden

[2] PEFC Italy, Italy

[3] University of Eastern Finland, Finland

[4] University of the Highlands and Islands, United Kingdom

Innovation in valuation and governing of forest ecosystem services to strengthen forest resilience and create pathways to societal impacts

Forest ecosystem are under the increasing pressure of changing climate and exacerbating challenges in the global context, due to political and socio-economic developments, including the Russian war against Ukraine. The call for green transition and circular bioeconomy has put pressure on forests, as the demand for timber and wood energy has increased significantly. Climate-induced changes interact with other threats to biodiversity. Besides, growing demand for social and cultural services of ecosystems after the COVID-19 pandemic has posed challenges regarding sustainable multifunctional forest governance and use. These and other challenges, and recent policy documents advocate developing of integrated and end-user-oriented methodologies, tools, and new, holistic, transdisciplinary approaches to ecosystem services (ES) valuation. Given the complexity of forest governance, it is important to design & apply ES valuation in a socially innovative, participatory environment that enables wider incorporation of inputs from stakeholders, with added value of data obtained by citizens science and spatial analysis on factors which support the interpretation of ES context and changes through time. Putting innovation in the centre, the proposed session will address the following main questions:

- What are the critical knowledge gaps in ES valuation?
- Which dimensions of value would it be helpful to address?
- How could these values be better captured, measured, assessed?
- How can stakeholder values be incorporated in valuation to support decision-making?
- In what way can ES valuation help define priorities in implementing ecosystem restoration and sustainable forest management?
- How can we consider distributional issues in natural capital (NC) accounting?
- How can forest policy and governance benefit from ES valuation?
- How can ES valuation help finance nature-based solutions, resolve conflicts, and prevent and alleviate damages that inflict costs on society?

Knowledge advanced/shared in this session and subsequently would: i) add value to science; ii) enable/equip decision-makers; and iii) inform governance decisions, regarding resource allocation, management, and use. Innovative forest governance could rely on more accurate estimates of how ES contribute to the wellbeing, reflecting the complexity and heterogeneity of values and distributional aspects across space and scales, and for different users. Finally, added value derived from this session is anticipated in widening of the scope of valuation towards better assessing and accounting for natural and anthropogenic disturbances (including climate change impacts; losses/gains due to increased wildfires, and devastating effects on socio-ecological systems and economy of the Russian war in Ukraine) and it could assist in strengthening of forest/forestry resilience and create pathways to societal impacts.

Maria Prof Dr Nijnik[1, 2] , Mariana Dr Melnykovych[3], Anze Dr Japelj[4], Simone Dr Martino[1], Lidija Prof Dr Zadnik Stirn[5], Bernhard Pauli[3], Simo Sarkki[6], Cecil Konijnendijk Van-den Bosch[7]

[1] Social, Economic and Geographical Sciences Department, The James Hutton Institute, Scotland, UK

[2] UK Gov Expert Committee on Forest Science, UK

[3] School of Agricultural, Forest and Food Sciences (HAFL), Bern University of Applied Sciences (BFH), CH

[4] Slovenian Forestry Institute, SI

[5] University of Ljubljana, Dept. of Forestry and Renewable Forest Resources, SI

[6] University of Oulu, FI

[7] Nature Based Solutions Institute & Wageningen University & University of British Columbia (EU, NL, CAN)

Modelling forest scenarios as if people, climate and biodiversity mattered.

The forests of the planet, particularly in the tropics, are at a crossroads. The effects of land-use change, resource extraction and climate change are pushing these ecosystems towards a tipping point where their contributions to livelihoods and wellbeing risk being permanently damaged and forever changed. Tackling deforestation would make a major contribution to achieving the UN Sustainable Development Goals and ensuring the well-being of millions of the world's most vulnerable populations on the front line of climate change. Forests and their contribution to climate change mitigation, are at the nexus of many of the challenges the international community is facing from inequality and poverty to biodiversity loss, conflict and mass migration. The forests crisis has caught the world's attention following the mega-fires that have burned from the Amazon to Indonesia's peatlands, from the Iberian Peninsula to the boreal forests of Europe, Asia and North America. Responses to the ongoing forests crisis have come from the G7, corporations such as Nestle and P&G making deforestation pledges, the New York Declaration on Forests and the latest Glasgow leader's declaration.There is also mounting interest and dollars from both individuals and institutions in tree planting and forest restoration. Forests are now front and center on the global agenda.

And yet, whatever we are trying to do to stop deforestation and restore forests, it is not working. We need to do things differently. We need new forms of decision-making and collective action.

The purpose of this session is to invite participants to immerse themselves in design thinking methods and collectively explore alternative futures using games coupling social and ecological processes. We want them to discover, explore and rethink global strategies to stop deforestation and upscale forest restoration. A major difference between this session and all other forms of scenario design is that participants will collectively construct alternative scenarios on the basis of strategy games. In so doing, the session will address the following questions:

How can counterfactuals better incorporate human agency, biodiversity crises and climate change?

How can different worldviews be incorporated in the modeling of future landscapes?

How can the experience of change conveyed through the game impact values and beliefs and support transitional change among stakeholders?

This sessions will be very innovative - participants having the active role They will be required to register before hand. We invite participants from a diversity of backgrounds to join - policy makers, practictioners and academics.

Claude Garcia[1] , Anne Dray[2], Patrick Waeber[1], Mariana Melnykovytch[1], Natasha Stoudmann[3], Robert Nasi[4], Stephanie Mansourian[5], Michael Klein[6], Clemence Dirac[7], Ida Djenontin[8], Laurene Feintrenie[9], Maria Nijnik[10]

[1] University of Applied Sciences, Berne.

[2] ETH Zurich

[3] University of Tasmania

[4] CIFOR, Indonesia

[5] Task Force "Transforming Forest Landscapes for Futures Climates and Human Well-Being", Switzerland

[6] IUFRO-SPDC programme (Austria)

[7] Forest Ecosystem Services and Silviculture Section, Swiss Federal Office for Environment, Switzerland

[8] Penn State University, USA

[9] CIRAD, Montpellier France

[10] Social, Economic and Geographical Sciences Department, The James Hutton Institute, Scotland, UK

Modelling forest trajectories under climate stress and changing management

The services provided by the world's forests are under increasing threat from climate change and possibly unsustainable management. Planning how to manage forests thus requires modelling that can effectively quantify the risk profile over the coming decades. Such modelling is important whether the service in focus is wood production, carbon storage, facilitating biodiversity, or any other of the many functions that forests provide. It allows to explore the impacts of different future climate scenarios and management approaches. Yet the range of climate risks presents a substantial challenge to the field of modelling. Forests are starting to be subject to levels of drought stress, insects, pathogens and fire intensities that they have not evolved to cope with. Damage rates from long-standing disturbance agents such as storms also appear to be changing.

In concert with these changes in natural processes, implementation of a range of forest management actions are being considered, not only to mitigate climate stresses, but also to help forests meet a range of sustainable development goals. The interaction of unprecedented levels of stress alongside new management approaches means that past analogues alone are not enough to make reliable assessments into the future. Instead, an increasing focus on capturing key processes underlying stress and disturbance responses is needed. New modelling approaches are developing rapidly, e.g. in combination with remotely sensed data, or AI. There is also a need to develop appropriate networks, such that the latest knowledge from state-of-the-art modelling can be rapidly propagated to practitioners and policymakers who need it.

Recently, several pan-European research projects assessing interactions between forest stress and management have started. In parallel, the International Tree Mortality Network (an initiative of the IUFRO task force on tree mortality) has been working to link forest modelling more closely with field observation networks. This session will bring together forest modellers from across the spectrum of empirical to process-based traditions, along with key stakeholders, to share experiences, approaches and needs

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Thomas Pugh[1, 2] , Nadine Ruehr[3], Gert-Jan Nabuurs[4], Susanne Suvanto[5], Anja Rammig[6], Hans Verkerk[7]

[1] Department of Physical Geography and Ecosystem Science, Lund University, Lund, Sweden

[2] Birmingham Institute of Forest Research, University of Birmingham, Birmingham, UK

[3] Karlsruhe Institute of Technology, IMK-IFU, Garmisch-Partenkirchen, Germany

[4] Wageningen University and Research, European Forest Resources, Vegetation, Forest and Landscape Ecology, Wageningen, Netherlands

[5] Natural Resources Institute Finland, Helsinki, Finland

[6] Technical University of Munich, Munich, Germany

[7] European Forest Institute, Joensuu, Finland

Monitoring patterns and processes in natural forests to assess their contribution to climate-change mitigation

Developing new approaches for identifying, describing and monitoring natural forests is fundamental to fully framing their unique role in conserving and controlling biosphere dynamics. Natural forests (e.g. old-growth forests) are not only huge repositories of biodiversity but host the most carbon-dense land ecosystems in different biomes and can continue accumulating substantial amounts of carbon even when dominated by old trees.

In times of fast environmental changes and rising pressures over ecosystems, it is important to implement effective and comprehensive monitoring systems able to integrate structural and biodiversity dynamics, demographic processes, tree response to climate change and the alteration of ecological processes. Such knowledge, necessarily based on repeated, intensive field measurement campaigns of tree dynamics (growth, death, regeneration) and ecosystem properties (diversity, microhabitats, soil structure), can be greatly boosted when connected with new technologies. Remote sensing tools are increasingly enabling scientists to measure forest landscape attributes and dynamics with increased frequency and precision, or in-situ sensors allow the high-resolution monitoring of tree structure, growth and physiological response to the environment.

This session will welcome contributions presenting new knowledge applied to quantify different aspects of natural forest dynamics contributing to their C accumulation and climate change mitigation. Specifically, the session will target approaches quantifying demographic dynamics, their integration with remote or on-site sensing tools and modelling approaches to predict biomass dynamics, structural complexity and biodiversity, attributes connected to increased naturalness, ecosystem integrity and stability under climate change. The final aim will be to gain the most informative knowledge to understand and forecast natural forest response to and mitigation of climate change.

The session will be based on oral and poster contributions. Talks will be selected among those presenting the widest and most innovative research approaches. A wide and comprehensive poster session will allow to showcase and discuss the widest array of case studies.

The activities will be organized by IUFRO Research Units: 1.01.07 “Beech Ecology and Silviculture” and 8.01.01 “Old growth forests and forest reserves”.

Alfredo Di Filippo[1] , William Keeton[2], Parisa Panahi[3], Khosro Sagheb-Talebi[3]

[1] Università della Tuscia, DAFNE, Viterbo, Italy

[2] University of Vermont, USA

[3] Research Institute of Forests & Rangelands (RIFR), Tehran, Iran

Moving towards digital forests for a sustainable future

Forest ecosystems provide numerous environmental, economic, and social benefits to people in urban and rural areas worldwide. Promoting and strengthening the sustainable use of forests requires updated methodologies and novel approaches. This is particularly relevant for forest monitoring, biodiversity conservation, and assessing the impacts of current and future uncertainties, such as disturbances in the context of climate change. In this regard, the wide range of active and passive remote sensing data provide new opportunities at different spatio-temporal scales. Such geospatial data open the door towards various approaches and applications, including highly automated data mining processes, spatial information systems, decision support systems (DSS), as well as state-of-the-art visualisation methods (virtual, augmented, or mixed reality). Furthermore, new advancements in geospatial data processing employing artificial intelligence, such as machine learning, have highlighted their importance for the future of forestry applications. In this session, we welcome novel methods and applications of remote sensing to address a wide range of forestry topics: forest inventory, biodiversity and habitat monitoring, assessment of global change impact on forest ecosystems, data support for DSS, and ecosystem service provision. Sessions within this theme will consider remote sensing and machine learning applications to derive relevant forest parameters that can assess the state of forest ecosystems and their functions. We welcome comparisons between new applications and datasets for forest monitoring; applications of new machine learning and deep learning algorithms in forestry and the contributions of DSS to forest management and planning.

Verena Griess[1] , Martin Mokroš[2], Mirela Beloiu[1], Fanny Petibon[1], Lars Waser[3], Amanda Mathys[1], Arnadi Murtiyoso[1]

[1] Institute of Terrestrial Ecosystems, ETH Zurich, Zurich, Switzerland

[2] Faculty of Forestry and Wood Sciences, Czech University of Life Sciences Prague, Czech Republic

[3] Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Zürcherstrasse 111, 8903 Birmensdorf, Switzerland

New directions for legal context of forest ecosystem services towards 2050

For many years now, forestry has been recognized as a global issue and sustainable multi-purpose forestry has become the guideline for government's policy in many countries. Successful development of the forestry sector in terms of sustainable management of forests has been depending on the existence of appropriate and effective legal and institutional frameworks. However, due to recent rapid changes in environmental, economic and social conditions, such frameworks need to be revised and improved to resolve problems and meet new challenges as they arise. Forest and environmental legislation, being a regulative tool of forest policy and thus undoubtedly part of such frameworks, shall face a number of important challenges – environmental (e.g., global climate change), economic (e.g., bioeconomy reinforcement) as well as social ones (e.g., population growth). The question is: Do we have such legislation and, if not, do we know how to improve or even establish it? Building on the IUFRO RG 9.06.00 work on legal aspects of sustainable forest development, which has led to the collection and analysis of a vast number of case studies (from more than 50 countries, over 25 years), the objective and anticipated contribution of this session shall be to give an answer to the defined questions and discuss the new directions for development and implementation of forest and environmental legislation, especially in the following areas: (i) legal rules of institutional arrangements in the forestry sector in order to support livelihoods and quality of life of local communities, especially in rural areas, (ii) public access to forests and fault liability of forest owners in order to provide recreation and other cultural forest ecosystem services, (iii) tenure rights and forest law enforcement in order to secure stable production of wood as a basic material source for bioeconomy. Moreover, two general areas may create a synergistic room for the applied jurisprudence debate – one of them being the perception of forest ecosystem services as the object of public and private law and the other the potential outline of international legally binding agreements on forests.

Rastislav Sulek[1] , Peter Herbst[2], Ikuo Ota[3]

[1] Technical University in Zvolen, Slovakia

[2] Forest legal consultant in Villach, Austria

[3] University of the Ryukyus, Nishihara, Japan

New solutions for challenges in decision support for mitigating disturbances to increase forest health and resilience under climate change

Forests are key elements to mitigate negative impacts of climate change by providing fossil-free products, thus reducing CO2 emission also maintaining biodiversity. Globally, forest ecosystems are facing different abiotic and biotic disturbances reducing their vitality, concerning both managed and unmanaged forests. Experts in various international, national and local organizations have a key role in producing new knowledge, data and tools for decision-making, management and mitigation concerning forest damage on different scales. This includes research, monitoring, analysis, method development and education, to highly important co-operation and communication. The knowledge provided and tools developed depend on the organizational level (global-local), and can be highly context-specific, for example on the geographical and national conditions including climate, vegetation and local ecosystem, historical and cultural background and socioeconomic situation.

Forecasts predict increasing forest disturbances like more frequent weather extremes, pests and pathogens attack and novel distribution, as well as a closer inter-correlation among these disturbances with changing climate, thereby threatening the ecosystem services forest provide. Thus, there is an urgent need for developing and improving research, monitoring, but also communication, and collaboration among the different organizations within the forest sector focusing on forest disturbances and their mitigation.

Today, most modelling tools and mitigating measures are still limited in considering single disturbance agent at a time. To mitigate negative impacts of climate change, it is important to consider the impacts and interactions of multiple damaging factors such as wildfires, storms, droughts, pests, and pathogens simultaneously in our decision-making and practical tools. Here, accurate knowledge on data and tools used for decision-making as well as identifying tradeoffs and synergies among various adaptive measures on conflicting ecosystem services are especially important for context-specific planning within future forest management.

The objective of this session is to share new knowledge, experiences, current and future challenges, and novel tools and practical solutions between researchers and stakeholders working with forest damage and their mitigation.

We are inviting speakers all over the world to share how they produce new knowledge, which tools and methods they are using, what are the current and future challenges they encounter, how they co-operate with others (regionally or locally) and how they transfer the knowledge to the practical solutions considering forest damages and their mitigation. Presentation can include description of current and future challenges, examples of the new knowledge, data and methods developed and applied, as well as practical cases how the produced knowledge is harnessed to practice.

Inka Bohlin[1, 2] , Narayanan Subramanian[1, 3]

[1] Forest Damage Centre, Swedish University of Agricultural Sciences

[2] Department of Forest Resource management, Swedish University of Agricultural Sciences

[3] Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences

Operational tools improving forest biodiversity Monitoring from space: Finding solutions to 2030 conservation targets

The preservation of biodiversity has become a major challenge for sustainable development at local, national to global levels. To address the current forest conservation needs, we need operational methods to assess the distribution of natural resources while integrating information on habitat conditions; inform conservation planning, and support the assessment of forest ecosystem services. The understanding of complex processes at the forest landscape level can be supported by the variety of sensors available and the ability to develop original methods to use and combine information resulting in opportunities to predict the consequences of changes in drivers at different scales and plan for more efficient mitigation measures within a context of global change. This session aims to showcase a series of studies and robust frameworks that demonstrate how coupling remote sensing, artificial intelligence and ground observations with models can provide operational solutions toward a better understanding of complex forested landscape processes to support efficient planning toward sustainable management. In the end, we aim at discussing the role of innovative tools and coupling models to find ways to better capitalise monitoring forested landscapes globally.

Increased access to satellite imagery and new developments in remote sensing data analyses coupled with species models and artificial intelligence can support biodiversity conservation targets by stepping up monitoring processes at various spatial and temporal scales. More satellite imagery is indeed becoming available as open data, while remote sensing–based techniques are constantly developing, offering a plurality of application options. Even further, the coming observations that enable monitoring ecosystem extent and other essential biodiversity variables go far beyond products of the past in terms of spatial and spectral resolution and, consequently, the types of ecologically relevant measures that can be generated to improve the state and management of resilient forested landscapes.

The variety of sensors available and the ability to develop original methods to use and combine information has resulted already in many forest ecology applications: the availability of image archives (Landsat) and the development of satellite constellations like Copernicus contributes to global monitoring of forest ecosystems while cutting edge technologies such as imaging spectroscopy, LiDAR and RADAR provide new perspectives on the possibility to accurately map phenology, species diversity, community distribution, leaf traits, biomass, and ecosystem extent contributing to filling the biodiversity data knowledge gap.

Sandra Luque[1] , Justin Morgenroth[2], Dino IENCO[1]

[1] INRAE, National Research Institute on Agriculture, Food & the Environment, Unit TETIS Land, environment, remote sensing and spatial information UMR TETIS Land, environment, remote sensing and spatial information, France

[2] School of Forestry | Kura Ngahere University of Canterbury, NZ

Predicting the future of forest ecosystems from contemporary spatial patterns

Experimental studies simultaneously addressing impacts of multiple abiotic global change drivers on structure and functions of forest ecosystems remain logistically challenging and therefore scarce. The accumulated knowledge pertains mostly to the effects of temperature, precipitation and CO_2 elevation on tree growth and physiology, whereas the effects of these factors on biotic interactions (especially those in belowground ecosystem compartment) are insufficiently known. The findings of experimental studies, which are often limited to a certain taxon and which often manipulate only one of many co-occurring environmental factors, are difficult to use for predicting changes in forest ecosystems as the climate warms. Alternative approach to predict these changes is offered by macroecology.

The studies of the structure and functions of forest ecosystems in geographical gradients can improve an understanding of how abiotic, biotic and phylogenetic factors concomitantly influence ecosystem structure and functions/services and permit the prediction of temporal changes in ecosystems from contemporary spatial patterns, an approach known as space-for-time substitution. Because climate is the primary driver of latitudinal and elevational patterns in biotic interactions, geographical gradients have been promoted as natural laboratories for studying the potential impacts of a changing climate on terrestrial organisms at immediately relevant spatial scales. This approach is increasingly used in fundamental ecology, but its applicability to forestry research remains to be seen through more applied examples.

The proposed session will bring together researchers with different backgrounds, who are exploring spatial patterns in forest ecosystems and who are using these patterns for predicting the future of forests. We will invite presentations (i) documenting latitudinal/elevational changes in forest ecosystems, (ii) identifying the sources of variation in these patterns, (iii) searching for similarities and dissimilarities between latitudinal and elevational changes in forests, (iv) searching for similarities and dissimilarities between spatial and temporal changes in forests and (v) discussing research biases that could compromise the use of contemporary spatial data for predicting the future of forest ecosystems.

Mikhail Kozlov[1] , Bastien Castagneyrol[2]

[1] Department of Biology, University of Turku, Finland

[2] French National Institute of Agricultural Research - INRA, France

Role of university and experimental forests in the forest education and long-term forest research

University or experimental forests play a key role in developing innovative forest technology and theories in forest science. University or experimental forests provide basis where research know-how and data are succeeded through education. University forests are usually the place where young scientists begin their first experiments and old scientists inherit their experiments to their successors. Most of university or experimental forests provide long-term research often over 100 years thanks to its specific academic position.

The session deals with scientific findings and academic roles of university and experimental forests and will discuss the ways to develope the function of university and experimental forests as well as the collaboration among university and experimental forests.

The session aims to

- Introduce research and scientific findings in university and experimental forests across diverse regions
- Identify the specific role and exploring future research university and experimental forest should provide
- Seek to enhance the collaboration among university and experimental forests within and across regions.

The session consists of oral, poster and flashtalk presentations.

Pil Sun Park[1] , Hosang Kang[2]

[1] Department of Agriculture, Forestry, and Bioresources, Seoul National University, Republic of Korea

[2] Institutes of Green Bio Science and Technology, Seoul National University, Republic of Korea

Simulation and automation in modern forest operations

Forest operations in different parts of the world face challenges of improved safety, cost efficiency, productivity, social acceptance, and alignment to ecological demands. These challenges have to be addressed with all available means, and one important way to push forward is the adoption of emerging and advanced technologies for digitalization in the planning, execution, and control of forest operations. This involves remote and on-board sensing, data analysis and machine learning, modelling, and computing to increase the density of data and knowledge throughout the value-chain. The goals are diverse but can involve i) higher levels of automation ii) simulation of new machines or systems (including electrification) as well as improvements of existing systems iii) new operator support systems iv) creation of algorithms to solve problems or tasks previously too complex. Presenters are encouraged to write innovative abstracts that combine different sources of data, computational models, and analysis techniques that may transform future forest operations.

Mikael Lundbäck[1] , Martin Servin[1], Ola Lindroos[2], Alexandra Marques[3], Ruben Valbuena[4]

[1] UMIT Research Lab, Department of Physics, Umeå University

[2] Department of Forest Biomaterials and Technology, Swedish University of Agricultural Sciences

[3] Collaborative Laboratory for Integrated Forest & Fire Management, Quinta de Prados, Campus da UTAD, Portugal

[4] Forest Remote Sensing, Department of Forest Resource Management, Swedish University of Agricultural Sciences

Taking advantage of technology in education

More widespread use of digital tools and other technological solutions are crucial in today's working life. The application of technology in forest operations has also demonstrated efficiency, effectiveness, and accuracy. However, the availability of technology in forest education around the world is not homogenous and thus some regions face severe and several challenges to apply modern technological solutions in the forest sector (Rekola and Sharik, 2022). This session aims to discuss how to mobilize technological *resources* and how to modify teaching *methods* and curricula that lead to technological *advancements* in the forest sector.

Rekola and Sharik (2022) revealed that North America and Europe have sufficient technological *resources*, Asia Pacific and Latin America and the Caribbean regions reported moderately available technological tools, and Africa and North East Africa reported quite limited availability of technology in their forest programs. The lack of technological resources jeopardizes the ability of forest professionals to perform in their jobs and implies a disadvantage for students who don't have access to technology.

Teaching *methods* have changed rapidly in recent years due to Covid-19 which forced students and professors to engage in technology literacy practices. Therefore, an ability to assess, acquire, and communicate information in a fully digital environment has seemingly increased. However, technology literacy is not enough for a forest professional to succeed. There is a need for students to utilize the technology beyond the traditional platforms and apply them to propose solutions that contribute to the sustainability of the forest and e.g., to enhance the quality of life of forest dwellers.

One of the educational technological *advancements* is to use AR/MR/VR solutions. They have been an option in the realm of education for more than 20 years. However, their widespread adoption has not yet occurred. The best use of these solutions can make it easy to access rare and difficult learning subjects such as endangered species in tropics. These immersive solutions may also increase the intrinsic motivation of students and improve learning outcomes (Holopainen et al. 2020).

References:

Rekola, M., Sharik, T.L. 2022. Global assessment of forest education. Forestry Working Paper No. 32. Rome, FAO.

Holopainen, J., Lähtevänoja, A. J., Mattila, O., Södervik, I., Pöyry, E., & Parvinen, P. (2020). Exploring the Learning Outcomes with Various Technologies: Proposing Design Principles for Virtual Reality Learning Environments. In *Proceedings of the 53rd Annual Hawaii International Conference on System Sciences*. University of Hawaii.

Rene Zamora-Cristales[1] , Patrick D. Culbert[2], Sara Käkönen[3], Niclas Sandström[4]

[1] World Resources Institute, United States

[2] University of British Columbia

[3] 3DBear

[4] Forum4edu

Teaching and training in silviculture: contemporary challenges and future prospects

This session is a joint venture between IUFRO Division 1, the IUFRO-IFSA Task Force for Forest Education and IUFRO Division 9. We will discuss the challenges in teaching and training in silviculture and the work prospects for students once they graduate.

There are three main challenges for the classical approach to teaching in silviculture: (a) the economic basis for running a course, (b) the increasing diversity of students, and (c) the staff reductions and increasing automation in operational forestry.

The economic basis is a major problem because silviculture courses generally are allocated similar budgets as other, purely classroom-based courses. For silviculture courses this is due mainly to transportation costs and it severely challenges the use of field tours as an integral part of the teaching.

The increasing diversity of students is a pedagogic challenge. Many forestry curricula are based on optional subjects rather than following an essentially fixed progression of courses with a gradually increasing complexity. Moreover, students from other professions may wish to attend silviculture courses. Consequently, due to the lack of basic skills among some students, this generally lowers the entry-level requirements, demands more basic knowledge to be included in the course and prevents the course from reaching into advanced level silviculture, silviculture in the context of forest governance, and the social processes associated with silviculture and communication about silviculture.

Staff reductions in operational forestry has a major impact on teaching options simply because the remaining potential hosts for field tours have less time available for apprentice training, supervision and teaching. This makes it increasingly difficult for forestry staff to plan and conduct field tours and to host students, and many decline to do so due to other competing and sometimes urgent work.

Remote-distance teaching, virtual reality facilities and electronic media can help alleviate some of these problems, but also pose challenges for the indispensable hands-on training in silviculture courses.

The session will discuss issues relating to the teaching situation and curricula as well the linkages between forest education and employability of present day students and future forest and forestry professionals.

Jens Peter Skovsgaard[1] , Sandra Sandra Rodríguez-Pineros[2], Monica Gabay[3]

[1] Swedish University of Agricultural Sciences, Sweden

[2] Autonomous University of Chihuahua, Mexico

[3] DN Gestión Ambiental del Agua y los Ecosistemas Acuáticos

Temporal, spatial and big data – Challenges for modelling climate change impacts on forest tree and stand growth

Monitoring of and collection of data on forest growth has been the cradle of forest sciences. Time series of forest tree and stand data from repeatedly measured long-term forest research plots and spatially distributed data collected by forest inventories are data types that are used for the analysis and modelling of forest growth. Due to emerging methodologies and technologies, we now have the capacity of enhanced forest monitoring and inventory via developments in remote sensing (e.g., Sentinel), advanced data acquisition systems (e.g., airborne and terrestrial LiDAR, FACE facilities), as well as in information and communication technologies (e.g., big data, artificial intelligence).

Compared to conventional data, the quality of such new data accessible for the analysis and modelling of forest growth increases in terms of data volume, variety of data types and sources, and velocity of data generation, processing and transfer. This poses conceptual, methodological and technological challenges for modelling climate change impacts on forest tree and stand growth.

Improved understanding of mechanisms that drive temporal trajectories and spatial patterns of forest growth processes is prerequisite for conceptualizing robust predictive models. Statistical methods are increasingly advanced to capture relevant information from data and sophisticated software tools are developed to apply these to data.

The focus of this technical session is on these challenges and their exploration by presenting evidences and examples from forests all around the world. Knowledge gaps and solutions to robust forest growth projections will be discussed including as well disturbance and mortality studies and tree- and stand-level approaches. Consequences for dedicated university teaching modules will be examined.

Hans-Peter Kahle[1] , Harri Mäkinen[2], Aaron Weiskittel[3]

[1] Chair of Forest Growth and Dendroecology, University Freiburg, Germany

[2] Natural Resources Institute Finland (Luke), Helsinki, Finland

[3] Irving Chair of Forest Ecosystem Management, University of Maine, United States of America

The new age of forest monitoring: A common European forest monitoring system in a global perspective

The transition to a sustainable, low-emission circular bioeconomy has to be guided by policies and actions that are based on accurate and timely information. Forests play a key role in this transition as they deliver important raw materials, store carbon, host biodiversity and provide many other ecosystem services. In addition to anthropogenic activities, forests are also affected by changes in averge climate and extremes, whose combined effects are not fully understood largely because monitoring activities are still not adequate. Although National Forest Inventories (NFIs) and other field-based monitoring initiatives exist in most European countries and huge amounts of useful data are acquired by several constellations of remote sensing platforms, no common European forest monitoring system exists today. As described in the new EU Forest Strategy for 2030, the European Commission aims to improve this situation. Several major research projects have recently been funded to create knowledge for a new age of European forest monitoring, that will link to and inspire other forest monitoring networks worldwide.

This session is organized by the coordinators of these European projects and will present research highlights on the topic, leveraging on the combination of remotely sensed and field-based observations (by NFIs and other networks) and providing a broad understanding on how a large-scale forest monitoring system could help achieve sustainability, climate and biodiversity targets.

Besides high-level presentations, this event (session and panel discussion) will include a panel discussion with key users and decision makers that require reliable information on forests. This event will link to several technical sessions on forest monitoring.

Johannes Breidenbach[1] , Alexia Stokes[2], Ruben Valuena[3], Alessandro Cescatti[4], Gherardo Chirici[5], Fulvio Di Fulvio[6], Hans Verkerk[7]

[1] National Forest Inventory, NIBIO - Norwegian Institute of Bioeconomy Research, Norway

[2] CIRAD - French Agricultural Research Centre for International Development

[3] SLU - Swedish Agricultural University, Sweden

[4] JRC - Joint Research Center, European Commission

[5] University of Florence, Italy

[6] IIASA - International Institute for Applied Systems Analysis, Austria

[7] EFI - European Forest Institute

The next generation of forest decision support systems for tackling today's and future challenges!

The pressure on forest ecosystems is increasing. They are expected to contribute to climate change mitigation by substituting fossil fuels and storing carbon, as well as provide beneficial conditions for biodiversity, timber production, recreation, and other important ecosystem services. At the same time, forest management needs to adapt to a changing climate. Management decisions have thus become very complex and need to deal with conflicts between different management objectives and increasing uncertainties.

Forest decision support systems (DSS) are important tools in decision making about forest management and governance. Forest DSS helps decision makers and stakeholders to assess the consequences of different management options, and to find management alternatives that reach various management goals. Thus, the long and short-term analysis that a forest DSS provides can help alleviating conflicts between different management objectives by, among others, revealing trade-offs and synergies.

Historically, forest DSS have mainly been used to estimate the maximum sustainable yield. Traditionally, forest DSS have been based on empirical growth and yield models and assumptions of forest owner/manager harvesting behaviour. However, given the need for multifunctional forest management and new challenges connected to the adaptation to and mitigation of climate change, there is a need for a new generation of forest DSS. While many of today's forest DSS can deal with more ecosystem services than timber production, they often lack functionality for dealing with uncertainties, in particular related to the effect of future climate change. Such aspects are however essential for authority and credibility with decision-makers and other stakeholders. In addition, there is a need to make the results produced with the help of forest DSS more accessible and easily understood, in order to allow for inclusive and participatory discussions among a wide range of stakeholders and decision makers. All these needs make it urgent to exchange ideas on changed and novel functionalities and results provided from the next generation of forest DSS, and to promote collaborations between different countries and research groups within this topic. The objective of this session is therefore to gather researchers from around the world to co-create knowledge on how to create modern forest DSS that are able to provide an informed decision basis to forest stakeholders facing today's and tomorrow's challenges.

Karin Öhman[1] , Jeannette Eggers[1], Lars Sängstuvall[1]

[1] Swedish University of Agricultural Sciences, Department of Forest Resource Management

Towards a global observatory of forest dynamics

Forests are home to 80% of the terrestrial biodiversity, much of Earth's carbon, and many of its peoples. With global change posing new stresses, the great carbon sinks may be shutting down in even the most remote standing forests. There has never been a greater need to know what is happening to forests, where, and why, and to use that information to sustain our future. One of the problems behind the lack of a global picture of forest dynamics is that we lack integration between approaches that can quantify the processes within the forests (i.e. long-term inventory plots and experiments) and those which can generate information across large scales (i.e. remote sensing and vegetation models). While we understand the trajectory of forests in certain regions, such as North America and Europe, other forests are complete unknowns in terms of their biodiversity and ecosystem services. Currently, we have several networks and national forest inventories that can generate a national to regional picture of tree mortality and growth. However, there are only very limited efforts to integrate the results of these studies into a coherent global picture. In parallel, some initiatives such as the alliance for tropical forest science (ATFS) and the International Tree Mortality Network (an initiative of the IUFRO task force on tree mortality) have been calling for an integration between ground-based observations, models and satellite data. This session is a call to researchers and practitioners working on forest dynamics from different regions and approaches to discuss ways forward to create a global picture of forest dynamics.

Sheila Ward[1] , Adriane Esquivel Muelbert[2, 3], Thomas Pugh[2, 3, 4], Svetlana Saarela[5], Kauane Bordin[6], Hans Juergen Boehmer[7], Miroslav Svoboda[8]

[1] International Society of Tropical Foresters, Puerto Rico, USA

[2] School of Geography, Earth and Environmental Sciences, University of Birmingham, UK

[3] Birmingham Institute of Forest Research, University of Birmingham, UK

[4] Department of Physical Geography and Ecosystem Science Lund University, Sweden

[5] Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences, Norway

[6] Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, Brazil

[7] University of Hannover, Germany

[8] Czech University of Life Sciences, Faculty of Forestry and Wood Sciences, Czech Republic

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