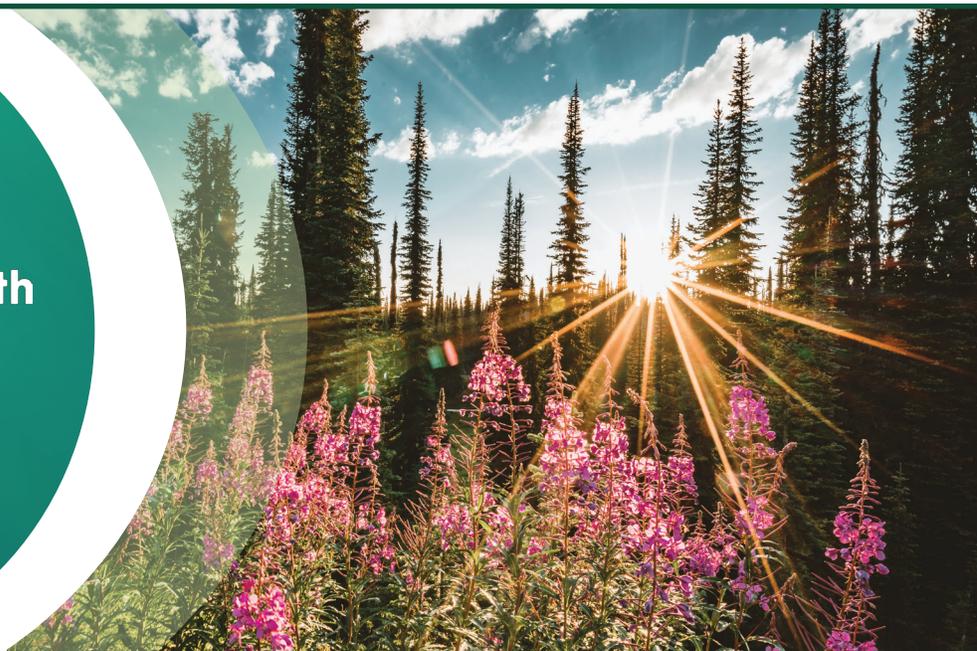


# PROCEEDINGS OF THE 20TH COMMONWEALTH FORESTRY CONFERENCE (ABSTRACTS)



August 16-18, 2021

Virtually hosted by the Faculty of Forestry  
at the University of British Columbia

Vancouver, British Columbia, Canada

## Friends and Sponsors





THE UNIVERSITY OF BRITISH COLUMBIA  
**Faculty of Forestry**



University of British Columbia

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This electronic publication includes abstracts from papers presented during the 20<sup>th</sup> Commonwealth Forestry Conference, held online from Vancouver, British Columbia, Canada.

The Conference was organized jointly with the Commonwealth Forestry Association and hosted by the Faculty of Forestry, University of British Columbia on August 16 – 18, 2021.

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### **Forestry Innovation Investment**

Forestry Innovation Investment (FII) is the province's market development agency for forest products. Through partnerships with industry and other levels of government, we help maintain, create and diversify markets for B.C. forest products to ensure the forest sector continues to be a key contributor to the B.C. economy.

Developed by FII, [naturally:wood](http://naturallywood.com) is a comprehensive information resource that promotes B.C. as a source of quality, environmentally-responsible forest products from sustainably managed forests. It includes details on B.C. forest management, forest products, species, wood design, and emerging trends. Visit [naturallywood.com](http://naturallywood.com) to explore these and many more resources.

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### **Association of BC Forest Professionals**

With more than 5,300 Registered Professional Foresters and Registered Forest Technologists, we regulate the largest group of forestry professionals in Canada. The Association of BC Forest Professionals is responsible for registering and regulating British Columbia's professional foresters and forest technologists. Here in BC, the practice of professional forestry has been regulated since 1947 when foresters first agreed to help protect the public's interest in the province's forests in return for the exclusive right to practise forestry. Today, we are the largest professional forestry association in Canada and the first to include forest technologists.

<https://abcfp.ca/web>



**FPAC** provides a voice for Canada’s wood, pulp, and paper producers nationally and internationally in government, trade, and environmental affairs. As an industry with annual revenues exceeding \$80B, Canada’s forest products sector is one of the country’s largest employers operating in over 600 communities, providing 230,000 direct jobs, and over 600,000 indirect jobs across the country. Our members are committed to collaborating with provincial governments, Indigenous peoples, other rights holders and stakeholders to develop a cross-Canada action plan aimed at advancing forest health, while supporting workers, communities and our environment for the long term.

**Asia Pacific Forest Education Coordination Mechanism**



Forests in the Asia-Pacific region serve nearly half of the global population. More than five million people work in the forestry sector in this region. However, the region’s forests face mounting challenges, such as a decline in forest cover, loss of biodiversity, damage to forest ecosystems and reduced ecosystem stability and resilience. To address these challenges, an improved and more innovative team of forestry practitioners is critical, and post-secondary forestry education and training will play a key role in creating this team. It will require closer linkages and synergies among forestry institutions and forest-related organizations in our increasingly globalized world.

Initiated by the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet), the Asia Pacific Forestry Education Coordination Mechanism (AP-FECM) was proposed during the First Forestry College Deans Meeting in 2010 and formally launched in a second meeting in 2011. Its objective is to develop concrete activities in support of the reform and improvement of forestry education in the region.



<https://cdnsiencepub.com/journal/cjfr>

The Canadian Journal of Forest Research is a monthly journal featuring articles, reviews, notes and concept papers on a broad spectrum of forest sciences, including biometrics, conservation, disturbances, ecology, economics, entomology, genetics, hydrology, management, nutrient cycling, pathology, physiology, remote sensing, silviculture, social sciences, soils, stand dynamics, and wood science, all in relation to the understanding or management of ecosystem services. The journal also publishes special issues dedicated to a topic of current interest. Such new knowledge should relate to the understanding or management of ecosystem services, as defined in the Millennium Ecosystem Assessment, Ecosystems and Human Well-Being: A Framework For Assessment, and should be of interest to an international readership. Methodological and modeling papers should include applications and provide a verification of enhanced performance.



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## Conference at a glance

### Attendance and Content

- 49 countries represented from 17 time zones
- More than 420 delegates, 34 % of them students
- 2.5 days - all online, session recordings (on-demand) available until January 31, 2022
- 10 Keynote Speakers, 5 distinguished speakers for opening and closing ceremonies
- 2 Special Sessions with 11 invited speakers
- 180 Presenters (oral and poster presentations)
- 3 Minute Talk Challenge for students: 1 slide, 3 minutes each, 13 contestants from around the world
- Light Up CFC Games: music and place-hunt

### Conference topics:

- Special session: Building Our Future (6)
- Special Session: Forest Stewardship Council (5)
- New Markets (Bioeconomy, Ecosystem services) (8)
- Education and Careers (Forest Education in the context of massive transition, Education Technology Development, Careers and Collaboration, Cooperation) (26 total + 1 keynote)
- Communicating forestry to outside audiences (5 + 1 keynote)
- Climate change (32 total) - Forest fires (7+ 1 keynote), Carbon sequestration (12 + 1 keynote), Insect outbreaks (2), Seed transfer (3 + 1 keynote), Communities (5)
- Technology and Innovation - vision for modern forest management (15 + 2 keynote)
- Conservation versus Consumption (46 total) - Indigenous and community forestry (policies, products) (8), Landscape-level approaches (17), Conservation valuation (3), National park management (10), Wildlife management (5), Old-growth management (2)
- Urban Forestry for Promoting Planetary Health (Valuation, Community engagement) (15 + 2 keynotes)
- IUFRO Divisions 6 and 9 (30 total) – Livelihoods (8), Traditional knowledge (3), Forest certification (2), Forest Policy (9), Social Aspects (5), Indigenous Forestry (3)

COUNTRY (# PARTICIPANTS)	
Australia (7)	Kenya (2)
Austria (2)	Liberia (1)
Bangladesh (3)	Malaysia (2)
Brazil (2)	Mozambique (2)
Cameroon (1)	Nepal (4)
Canada (207)	New Zealand (1)
Cape Verde (1)	Nigeria (13)
China (35)	Pakistan (3)
Columbia (1)	Peru (1)
Denmark (1)	Philippines (7)
Ethiopia (1)	Portugal (2)
Fiji (1)	Serbia (1)
Finland (2)	Sierra Leone (1)
France (1)	Singapore (3)
Germany (5)	South Korea (1)
Ghana (1)	Sri Lanka (2)
Hong Kong (1)	Switzerland (5)
Iceland (1)	Tanzania (2)
India (51)	The Netherlands (1)
Indonesia (4)	Turkey (1)
Iran (1)	Uganda (2)
Italy (1)	Ukraine (1)
Jamaica (4)	United Kingdom (12)
Japan (9)	United States (10)
Jordan (1)	

### This Conference’s Carbon Emission Saving:

More than 200 passenger vehicles driving for one year, or 1 passenger vehicle driving for 3.5 Million kilometers (or 4.5 times the distance to the Moon and back).

## Commonwealth Forestry Conference - Final Communiqué

*This 18<sup>th</sup> day of August, 2021*

The Commonwealth is home to 2.4 billion people, contains 813 million hectares of forests and 394 million hectares of other wooded land, and consists of 54 independent countries. From August 16<sup>th</sup> to 18<sup>th</sup> 2021 420 delegates from 54 countries are attending the 20th Commonwealth Forestry Conference hosted on-line from the University of British Columbia in Vancouver, Canada. Delegates wish to share the following insights from the Conference:

Commonwealth forestry leaders appreciate that forests are increasingly recognized for their contribution to effective and efficient solutions to some of the world's most pressing crises. In this critical year of international meetings of conventions of climate change, and biodiversity, delegates to the Commonwealth Forestry Congress encourage decision-makers to:

**Acknowledge, highlight, and recognize** the critical economic, social and environmental contributions of forest ecosystems to human well-being:

**Understand** that cross-sectoral and landscape-level approaches to forest management are crucial to sustainable development:

**Recognize** the broad array of opportunities and challenges facing different communities within the Commonwealth and worldwide, and the need to meet the needs and aspirations of the full diversity of people with interests in forests; delegates specifically:

1. Encourage the continued adoption of landscape approaches where local populations, especially Indigenous peoples, are fully engaged with decisions

about their forests and where balanced approaches to achieving the multiple benefits from forest lands are carefully negotiated;

2. Urge cooperation, reduced duplication of effort and cross-sectoral collaboration between all parties, both governmental and civil society, implicated in decision-making on forests;

**Recalling** that the forestry institutions in Commonwealth countries have considerable professional competence in multi-functional forest management and have existing plans and strategies that need to be considered in designing forest-related initiatives;

The participants in the 20th Commonwealth Forestry Congress emphasize that:

1. **Forestry initiatives are playing an increasing role in efforts in mitigating and adapting to global climate change.** The CFC strongly encourages forest institutions to ensure that initiatives to reduce greenhouse gas emissions and sequester carbon should be undertaken in ways that are consistent with the broader goals of sustainable forest managements.
2. **Forests are a key element in the transition towards circular, bio-based economies.** The CFC welcomes this growing role of forests in meeting global energy and material needs and sees this as providing greater impetus for sustainable forest management.
3. **Fires are increasingly threatening forests and their dependent communities**

- globally, due to a combination of global climate change, historical forest management, and fire exclusion and suppression. The CFC highlights the need for governments and citizens to prioritize proactive fire management over reactive fire response. The CFC urges governments to embrace the leadership and knowledge of Indigenous and local communities. The CFC also encourages proactive management to help reduce fuel loads, diversify forest structure and composition at the stand and landscape scale, and reintroduce cultural and prescribed fire management, where appropriate, to maintain fire-dependent forest ecosystems.
4. Many countries are actively engaging in **managing forests in partnership with Indigenous peoples and local communities** for tangible and intangible benefits. The CFC strongly encourages Commonwealth countries to pursue these initiatives and to develop inclusive forest governance arrangements that are adapted to local contexts and draw on traditional and local knowledge.
  5. Forests are home to 80% of the World's terrestrial biodiversity and we continue to lose biodiversity at an alarming rate. The CFC encourages an **increased consideration of biodiversity conservation as a major objective of sustainable forest management**.
  6. The CFC applauds major **global initiatives to restore degraded and deforested landscapes** but recommends that increasing attention is given to ensuring that restoration efforts are adapted to local contexts and are planned with adequate inputs from local communities.
  7. The CFC applauds the **increased attention given to urban forestry** and notes the physical and mental health benefits that are provided by urban trees and forests. Delegates note the importance of involving **urban communities as important stakeholders in all initiatives related to sustainable forest management**.
  8. The CFC notes with concern that "learning poverty" remains unacceptably high in many Commonwealth countries and that it is expected to increase as a result of the pandemic. The CFC recognizes the **importance of both formal and informal education in forestry**, particularly for younger generations, and this will be hindered if learning poverty is not reduced. These are our future forest managers, and it is crucial that they are well-equipped intellectually to address the many environmental and social challenges that they will face.

## Closing Keynote

By Sarah Dickson-Hoyle

*Sarah is a PhD candidate and the current Future Forests Fellow at the Faculty of Forestry, UBC. Originally from Australia, she has over ten years' experience spanning natural resource management, carbon forestry and ecological consulting. As an interdisciplinary social scientist and ecologist, and settler scholar here in Canada, her research is being conducted in partnership with Secwépemc First Nations to understand community and land-based recovery following the 2017 wildfires in BC, and to support Indigenous-led restoration and fire management.*

Good morning or good evening to everyone here with us virtually, wherever you are in the world. I am joining from Secwepemcúl'ecw, the traditional and unceded territory of the Secwépemc people in south-central British Columbia. And I am sharing these photos that you see rolling on the screen to give you a glimpse of this land and the people who I continue to work with and for through my research as a settler scholar, and to ground the thoughts I'll be sharing with you today in this context of place.

When I was invited to speak today to share my perspective, as a young forester, on the future of forestry, I have to admit I was a little hesitant. For one, I'm not sure how long into your 30s you can still claim to be a 'youth'. But more importantly, I've seen this set up one too many times. A young person is called upon to provide some much-needed energy or diversity to a conference stage; to offer hope and their vision for the future. We applaud them for their inspiring words, assure them the future is in good hands, and then we pat ourselves on the back and go back to business as usual.

So, when I did say yes, it was not to talk about the future. I want to talk about right now.

The recent IPCC report unequivocally states that human-induced climate change is already causing widespread and irreversible changes to our climate and ecosystems. We have just

over ten years to enact transformational change. We need deep reductions in emissions if we are to avoid the devastating impacts of a greater than 1.5 degree rise in global temperatures.

10 years.

We are not doing enough.

Here in BC, as in many places around the world, these impacts of climate change are already being felt.

As I speak, over 260 wildfires are burning throughout our province. The town where I am based for fieldwork is surrounded on all four sides by out-of-control fires. Each day I step out into a thick haze of smoke or ash raining from the sky; I watch helplessly as colleagues are evacuated, as whole communities are lost.

I have walked across streambeds dried up in the drought, and through fields of grass scorched in the record-breaking heat wave. I have seen forests that were once open and are now infilling with spindly saplings, and burnt stands of over-dense pine plantations that challenge Canada's claim to be a world leader in fire and sustainable forest management.

We are not doing enough.

At the same time, I have witnessed incredible strength and resilience.

We have watched the forest floor rebound with life and growth after fire – an abundance of traditional food and medicine plants that speaks to the longstanding interconnections between people, ecologies and fire in these landscapes.

I have seen First Nations mobilize to protect their communities and non-Indigenous neighbours from wildfire, their fire knowledge keepers working hand in hand with government agencies to lay down good fire. This is what my friend and advisor Ron Ignace, Elder and longstanding Chief from the Secwepemc Nation terms ‘walking on two legs’, Indigenous knowledge and western science in balance, guided by an Indigenous worldview.

And every day I continue to learn from my colleagues in community and my incredible field crew, who have taught me that looking forward also means looking back – understanding the ecological and cultural histories of these lands and recognizing the depth of knowledge found in Indigenous communities.

The IPCC report comes at a critical moment in our history. This year marked the start of the United Nations Decade on Ecosystem Restoration. The so-called generation restoration tasked with preventing and reversing ecosystem degradation on every continent and in every ocean. No small task – but then again, restoration is, fundamentally, a hopeful practice.

Simultaneously, governments worldwide have committed to implementing the United Nations Declaration on the Rights of Indigenous Peoples. Here in Canada – as in other settler colonial countries in the Commonwealth - we are once again grappling

with the history and ongoing impacts of colonization on Indigenous peoples and territories. Next year also marks the start of the UN Decade on Indigenous Languages. As Ron Ignace says, reconciliation without the revitalization of Indigenous languages, knowledges and lands is not reconciliation at all. I would argue the same is true for restoration.

A little over 10 years ago, the Commonwealth Forestry Conference was held under the ambitious theme of ‘tackling climate change’. In closing, they emphasized the need for leadership at all levels of society, and called on us, as foresters and forest scientists, to take action to bring about change.

I don’t think I’m alone in saying that change has not come fast enough. We are still not doing enough.

You might be thinking: ‘but we’re scientists and foresters – not policy makers or politicians!’ And you’d be right in thinking that individual action alone isn’t going to solve the climate crisis. We also need to individually and collectively push our governments and industries to make change at the scale needed: to divest from fossil fuels, promote renewables over pipelines, address biodiversity loss, and return stewardship of the land to Indigenous peoples.

But if you were trained in a time or paradigm that taught you to believe that good science is ‘objective’; that our role is merely to observe the world around us and report fundamental truths, I hate to break it to you – science is always political. The questions we choose to ask, the knowledge we deem valid, the projects we fund – these all reflect what we, as individuals and as a society, value.

The next time this conference meets, we will be halfway through that critical ten-year period. So I'll leave you today with a challenge – to take what you have learnt these past two days and use it to advocate for change – in your institutions, in your disciplines, in your communities.

In calling on us to take action, the 2010 Commonwealth Forestry Conference was acknowledging that scientists are, and should be, activists.

When we meet again in five years, I challenge you to come back with clear evidence that we are finally doing enough.

## Conference Program

All slots listed in Pacific Daylight Savings Time (PDT, UTC -7).

### Monday morning, August 16

Opening Ceremony | 6:30 am – 7:00 am

Dr. John Innes	Conference Chair Chair of CFA and Dean of Faculty of Forestry, UBC
Mack Paul	Traditional welcome from the Musqueam Band, xʷməθkʷəyəm territory
The Hon. Katrine Conroy	Minister BC Forests, Lands, Natural Resource Operations and Rural Development
Ms. Beth McNeil	Assistant Deputy Minister Natural Resources Canada – Canadian Forest Service
Ms. Alina Lehtikoinen	President International Forestry Students Association

Plenary (All-Conference) – Keynote 1 & 2

7:00 am – 8:00 am | Introduction by: Cecil Konijnendijk

Dr Savita	India	Keynote 1: Legacy from the 19th Commonwealth Forestry Conference and looking forward to the future of forests
Dr Harini Nagendra	India	Keynote 2: Urban forestry in the era of the Anthropocene: Science, education, action.

Special session 1: New Markets and applications: Building our Future

9:00 am – 12:00 pm | Chair: Jack Saddler

Ian de la Roche	Canada	Recent Trends in Building with Wood
Chunping Dai	Canada	Sustainable material developments with bamboo
Neil Tomas	UK	Building with Bamboo
Michael Ramage	UK	Growing the Future
Eric Karsh	Canada	Beyond the Case for Tall Wood
John Metras	Canada	The Evolution of Mass Timber Construction at the University of British Columbia
All		Panel discussion

Concurrent session 2.1. Education and Careers: Forest Education in the Context of Massive Transition

8:00 am – 10:30 am | Chair: John Innes

Alicja Kacprzak	Italy	Forestry Education in 21st Century: Trees to Global Socio-Ecological Systems
David Ekhuemelo	Nigeria	Appreciation of Forestry Profession amidst Forestry and Wildlife students in Some Nigerian Universities
August Temu	Tanzania	Future Specialized Forestry Education For Africa
Shashi Kant	Canada	Forestry Education in 21st Century: Trees to Global Socio-Ecological Systems
Michelle Zeng	Canada	Forest Education in An Online Environment: Lessons Learned during the COVID-19 Global Pandemic at UBC
Brigitte Leblon	Canada	TRANSFOR-M (TRANSatlantic FOREstry Master): a Canada-Europe award-winning dual-degree Master program for training globally-minded forest and environmental managers and scientists

Concurrent session 3. Communication

8:00 am – 10:30 am | Chair: Susan Gagnon

Neil Leveridge	Canada	Forestry communication in a virtual/hybrid world: transforming approaches to education and engagement
Alan Pottinger	United Kingdom	The Queen’s Commonwealth Canopy: promoting forests throughout the Commonwealth
Judith Vogel	USA	A Study of Maple Syrup Production in New Jersey
Terence Sunderland	Canada	Communicating science: A practical perspective
W. Keith Moser	USA	Expanding the role of the International Society of Tropical Foresters in knowledge/tech transfer for tropical sustainability

Concurrent session 6.1., 3 & 6 Conservation vs. Consumption: Indigenous & Community Forestry | Valuation | Old Growth

8:00 am – 11:00 am | Chair: Jeff Sayer

Sanjay Singh	Canada	Sustainable harvesting of <i>Mucuna pruriens</i> (Linn.) DC. from wild
Marie Nosten	Canada	Assessing the Pga’knyaw (Karen) rotational farming practice as a form of forest management and tool for land governance: a case study of Ban Klang, Lampang, Thailand
Rashmi Sehrawat	Canada	Indigenous Tree Borne oil seed: <i>Diploknema butyracea</i> (Cheura, The Indian Butter Tree)
Health Break		
Sarah Dickson-Hoyle	Canada	Equal partnerships in the era of ‘megafires’: lessons and leadership from Secwepemcúl’ecw
Renata Veiga	Canada	The social value environmental and fire stewardship programs: Insights from Australia and Canada
Nicholas Brokaw	United States	Old-growth dynamics in tropical forests of Belize

## Concurrent session 7. Urban Forestry for Promoting Planetary Health

8:00 am – 10:30 am | Chair: Cecil Konijnendijk

Robert White	Canada	Saskatoon's Hidden Forest- An afforestation project now a laboratory in ecological succession and a valuable urban forest on the Prairies.
Christina Geng	Canada	Impacts of COVID-19 pandemic on urban park visitation: a global analysis
Zhaohua (Cindy) Cheng	Canada	To what extent are climate change and urban forestry policies aligned in Canadian cities?
Syamili Manoj Santhi	India/UK	Context-specific Urban Forest Management: A Citizen Science Approach
Yuhao Lu	Canada	How "shady" are neighborhood trees: modeling Vancouver's urban canopy shading effect

## Concurrent session 8.1 &amp;2 IUFRO Div. 6 and 9: Livelihoods &amp; Traditional Knowledge

8:00 – 11:00 am | Chair: Stephen Wyatt

Sruthi Subbanna	India	Economic Analysis of Bambusa balcooa, Dendracalamus stocksii and Bambusa tulda in subhumid regions of Peninsular India
Angela Muthama	Kenya	Socio-economic impact of tree Pests and Diseases in Nakuru County, Kenya
Lucy Binfield	Canada	Bamboo industry development for poverty alleviation: What works?
Camilla Moioli	Canada	Income distribution and inequality analysis within the Conversion of Cropland to Forest Program: a case study from Jiangxi, Shaanxi, and Sichuan provinces in China
Dawit Guta	Canada	Misalignment of households revealed and stated tree-species preferences for firewood in the South of Chile and implications for native forests
Health break		
John Palmer	Canada	Cassava agrobiodiversity in the Guiana Shield: ecocultural resilience, global implications
Janette Bulkan	Canada	Producing cassava foods and drinks, re-producing Indigenous society in Guyana
Simay Kirca	Turkey	Reconstructing the historic fabric of Belgrade Forest (Istanbul) through its toponyms as a means to revitalizing conservation and restoration efforts
Elisabeth Johann	Austria	The appreciation of traditional forest-related knowledge as a starting point for future development - a case study of Austria

## Monday afternoon, August 16

Plenary (All-Conference) – Keynote 3 and 4

6:00 pm – 7:00 pm | Introduction by: John Innes

Suzanne Mavoia	Australia/ Canada	Urban forestry and human health
Julian Elder	New Zealand	The Future of Forestry – The Climate Change Challenge and Opportunity

Concurrent session 6.4 & 5 Conservation vs. Consumption: National Parks and Wildlife

4:00 pm – 8:30 pm | Chair: Cole Burton

Nabin Dahal	Japan	Conservation benefits globally costs locally: A case study of wildlife impact on food security in the adjacent community, Koshi Tappu Wildlife Reserve, Nepal
Margaret Calderon	Philippines	Enhancing the potential contribution of Almaciga ( <i>Agathis philippinensis</i> ) Resin Tapping to Indigenous Peoples in the Philippines
Analyn Codilan (presented by Vanessa Palma-Torres)	Philippines	Feasibility of Developing Almaciga ( <i>Agathis philippinensis</i> ) Tree Plantations in the Philippines
Baifei Ren	Canada	The Impact of Human Interference on Landscape Pattern in the Entrance Community of National Park
Pauline Suffice	Canada	Shifting paradigms: Promoting Indigenous Protected and Conserved Areas projects

### 6 – 7 pm All-Conference Keynote Talks 3 and 4

Christina Geng	Canada	Seasonal Variation in Visitor Satisfaction and Its Management Implications in Banff National Park
Fangbing Hu	Canada	Impacts of National Park Tourism Sites: A Perceptual Analysis from Residents of Three Spatial Levels of Local Communities in Banff National Park
Divya Soman	India	The Economics of Endangered Species Protection in a Protected Area: The Case of Parambikulam Tiger Reserve, Kerala, India
Suresh Chandra Gairola	India	Wildlife Management in India: Challenges, Strategies and Perspectives
Subhash Anand	India	Impacts of Forest Ecosystem Services on Livelihood Security and Sustainability: A Case of Jim Corbett National Park in Uttarakhand

Concurrent session 8.3 & 4 IUFRO Div. 6 and 9: Certification | Policy | Livelihoods

4 pm – 6 pm | Chair: Janette Bulkan

Juliana Lima de Freitas	Canada	Assessing how the beneficiaries perceive the constraints and benefits of FSC certification: a case study of Brazilian smallholders planted forests
Paul Johnson	United States	New Roadmap and Destination - SFI Urban Forest Sustainability Standard
Ryo Kohsaka	Japan	Impacts of forest environmental tax and multi-level collaboration: toward sustainable forest management scheme in Japan

Sudha Adhikari	Japan	Impacts of scientific forest management practices on forest user's livelihood- A case study from community forest in Lumbini Province Nepal.
Yoshitaka Miyake	Japan	Economic and environmental prospect of NTFP GIs in Japan: Empirical analysis of Joboji Urushi

Concurrent session 2.4 Forest Education Technology Development

7:00 pm – 9:00 pm | Chair: Guangyu Wang

Juan Pulhin, Roberto Figueroa	Philippines	Transforming Forestry Education through Technological Innovations
Michael Justason	Canada	Using the Lightboard to teach online
Kathleen Coupland	Canada	Untapped Resources: Increasing outdoor education by utilizing urban trees on a hyper-local scale
Dominik Roeser	Canada	Digital twin of the forest - how virtual reality can improve operational performance and land-based resource management
Patrick Culbert	Canada	Online teaching and learning
Anil Shrestha, Halina Chen, Shiyi Zhang	Canada	Lessons learned in delivering the Innovative SFM Online Courses Amid the Pandemic

Tuesday morning, August 17

Concurrent session 4.2, 4 & 5 Climate Change: Carbon Sequestration, Seed Transfer and Communities

5:00 am – 7:00 am | Chair: Sally Aitken

Seongmin Shin	Korea	Contribution of planted forests to climate change mitigation and adaptation
Pratibha Bhatnagar	India	Nature based solutions: Carbon Sequestration by Trees in Urban Parks and Gardens of Kaitni City, Madhya Pradesh, India
Md Saidur Rahman	UK	Biomass estimation in mangrove forest: a comparison of allometric models incorporating species and structural information
Sumit Chakravarty	India	Assessment of Home gardens for Carbon Market in Sub Himalayan Region of West Bengal, India
Swayne Beckles	Jamaica	Mitigating Climate Change - Building National Capacity in Carbon Stock Monitoring
Cindy Prescott	Canada	How can we sequester more carbon in forest soils?

Concurrent session 7. Urban Forestry

5:00 am – 6:00 am | Chair: Cecil Konijnendijk

Yuta Uchiyama	Japan	Access to urban forestlands during the COVID-19 pandemic: influence of environmental factors and reexploring values and functions of forest
Snowy Baptista	India	Living with leopards in a metropolis in 21st Century India
Ranjit Singh Gill	India	Inadequate space for urban forest in India's National Forest Policy - need for review

## Plenary (All-Conference) – Keynote 5 and 6

7:00 am – 8:00 am | Introduction by: Eli Koleva

John Innes	Canada	University forestry education after the epidemic: Will anything change?
Shannon Hagerman	Canada	Assisted migration and the reluctant acceptance of new forest interventions as a climate adaptation strategy

## Concurrent session 1. New Markets and Applications

8:00 am – 10:00 am | Chair: Scott Rennecker

Bala Prasad	India	Accelerated Growth in Non-Timber Forest Products Based Bioeconomy for Income Enhancement and Poverty Eradication in India and its Future Trajectory
Ludwig Liagre	Italy/UK	Which financing strategies can unleash forest-based industries engagement for ecosystem restoration?
Abosede Mustapha	Nigeria	Micromorphology and Phytochemical Screening of <i>Anthocleista djalonensis</i>
Alok Raj	Canada	Monitoring of Eco-biophysical dynamics using time-series MODIS data on GEE platform: A case of the Aravalli hills range (India)
Jubril Soaga	Nigeria	Economic values of ecotourism of selected natural sites

## Concurrent session 2.3 Forest Career and Collaboration

8:00 am – 10:30 am | Chair: Rob Kozak

Mika Rekola	Finland	Forestry Education and Student Competency
Troy V. Lee	Canada	Learning Forest Professionals: Meeting the Challenges of 21 <sup>st</sup> Century Forest Management
Jorma Neuvonen, Sheri-Andrews Key	Canada	UBC Forestry - Certificate programs
Casey Macaulay	Canada	What You Need to Embark on a Forestry Career in Canada
Sanya Sivic, Nazlyn Pirani	Canada	UBC Co-op program: Students and Employers engagement
Ben McArthur	Canada	The Greenest Workforce: An Information Hub for Job Seekers in Canada's Forest Sector
Elaine Springgay	Canada	ForYP: a Global Network for Forestry Young Professionals

## Concurrent session 4.2, 4 &amp; 5 Climate Change: Seed Transfer and Communities

8:00 am – 9:30 am | Chair: Sally Aitken

Muneer Magry	Canada	Community perceptions on changing climatic variables and their impact on Non-timber forest products.
José Lopes	Cape Verde	Community Empowerment for increasing adaptation and resilience to climate change in Cabo Verde
Alice Gargano	Switzerland	Tree rings say where to plant cacao trees in Ivory Coast (West Africa)
Sally Aitken	Canada	Time to get moving: Phenotypic and genomic approaches informing assisted migration in reforestation

Concurrent session 5. Technology and Innovation

8:00 am – 11:00 am | Chair: Chris Gaston

Suresh Chandra Gairola	India	Emerging Technologies and Innovations for Sustainable Forest Management in India
Juliana Magalhaes	Canada/ Brazil	Predicting Tree Growth Application Software: an emerging technology for modelling individual tree growth
Vinay Sinha	India	Reimagining Forest Science within Rhetoric of Massive Plantation Program
Sheila Ward	United States	Tapping into historical information for tropical forest management
Health break		
Stanislav Horzov	Ukraine	Forestry Supply Chain Management System Based Upon Blockchain Technology
Nicholas Coops	Canada	New Technologies for Forest Management
Rajit Gupta	India	Potential application of using full-waveform LiDAR remote sensing GEDI data with forest growth modelling in deciduous forest management

Concurrent session 6.2. Conservation vs. Consumption: Landscape Level Approaches

8:00 am – 12:00 pm | Chair: Jeff Sayer

Thirumurugan Vedagiri	India	Tree species diversity, community composition and recruitment pattern in a critical wildlife habitat of Peninsular India
Md Abiar Rahman	Bangladesh	Growing Trees in Agriculture Landscapes for Sustaining Production and Ecosystem Services in Bangladesh
Alicia Edwards	Jamaica	A Lesson in Resilience- Comparative Analysis of managed and non-managed Mangrove Areas in Jamaica
Health break		
Maria Vasconcelos	Portugal	REFLOR-CV – increasing the resilience of local communities to climate change in Cabo Verde
Angeline Van Dongen	Canada	Linear restoration by happy accident: The influence of forest harvesting activities on seismic line tree and shrub regeneration in upland mixed wood boreal forests
Jeffrey Sayer	Canada	How change happens in forest landscapes
Samuel Adeyanju	Canada	Learning from Community-Based Natural Resource Management in Ghana and Zambia: Lessons for integrated landscape approaches
Samuel F. Bartels	Canada	Impacts of retention harvesting on forest understory vascular plants: dynamics and recovery over nearly two decades in boreal mixed wood forests
Mike Fenger	Canada	Reforms needed for British Columbia's timber supply review process to actively embrace all forest values.

## Concurrent session 8.4 &amp; 5 IUFRO Div. 6 and 9: Forest Policy and Social Aspects

8:00 am – 11:30 am | Chair: Janette Bulkan

Madison Stevens	Canada/ India	Evaluating state responses to gender inequity in community forest governance, Uttarakhand, India
Stephen Wyatt	Canada	Understanding social diversity in Canada's forest sector through quantitative data
D. Sarada Devi	India	Nudge: On Enhancing Adaptive Capacity and Reducing Vulnerability Levels
Hang Ryeol Na	United States	International Political Economy of the Lacey Act Amendment of 2008
Sen Wang	Canada	The State of Canada's Forests Amid Three Decades of Sectoral Transformations
Health break		
Adinda Herdianti	Canada	Governing innovation and knowledge sharing to increase the adaptive capacity of forest industry in Quesnel, British Columbia
Emilio Valeri	Canada	Broader Participation Needed to Allow Forest Policies to Address New Challenges
Cristina Miranda Beas	Peru	The internal migration and forestry policies in Peru
Jean-Michel Beaudoin	Canada	Insights into employers' attitudes and behaviors regarding Indigenous workforce diversity

## Special session: Forest Stewardship Council

8:00 am – 10:00 am | Chair: Monika Patel

Alan Thorne	Canada	FSC's Global Strategy
Pina Gervassi	Germany/ Peru	Delivering Nature Based Solutions through forest certification, ecosystem services and restoration
Harrison Ochieng Kojwang	Kenya	Using FSC forest certification to promote and incentivize restoration in Africa
Cindy Cheng	Hong Kong PR China	New forest-based products – Textile sector in Asia
Francois Dufresne	Canada	Leadership in caribou conservation through voluntary certification

**Tuesday afternoon, August 17**

Happy Hour: Friends and Supporters | 3:30 pm – 4:00 pm

Concurrent session 8.6 IUFRO Div. 6 and 9: Indigenous Forestry

3:30 pm – 5:00 pm | Chair: Stephen Wyatt

François-Xavier Cyr	Canada - QC	Fairness and the implementation of a collaborative forest management agreement: The case of the Adapted Forestry Regime in Eeyou Istchee (Cree territory), Quebec, Canada.
Ratan Gurung	Japan	Implication of national forest and land legislation and property rights of customary leaf litter forest (Sokshing): Case from central Bhutan
Michelle Baumflek	USA - NC	Managing forests for culturally significant plants in traditional Cherokee homelands
Tonya Smith	Canada - BC	Following a Lil'wat approach towards reciprocal and relational forestry research

Concurrent session 4.1 Climate Change: Wildfires

3:30 pm - 9:30 pm | Chair: Lori Daniels

Kelsey Copes-Gerbitz	Canada	Community Forest collaborations lead proactive wildfire management in British Columbia, Canada
Maria da Conceição Almeida Colaço	Canada	REFLOR-CV: Fires, desertification and communities
<i>5:00 pm 3MT Challenge (All-Conference)</i>		
<i>6:00 pm Poster Session (All-Conference)</i>		
<i>7:00 pm Keynote speaker (All-Conference) - Michael Norton (Canada) on Climate Change and Wildfires</i>		
<i>Campfire Session continues at 8:00 pm to 9:30 pm</i>		
Mike Flannigan	Canada	Wildfires and Climate Change
Amy Christianson	Canada	Indigenous fire stewardship
Phil Burton	Canada	Addressing Anomalies in the Behaviour and Severity of Recent Large Fires in Central British Columbia
Lori Daniels	Canada	Wildfires in British Columbia: Causes, Consequences and Coexistence
Tony Bartlett	Australia	The challenges and role of fire in Australian forests under a changing climate

3-Minute Talk Challenge (All-Conference) – Part 1 of 2

5:00 pm – 6:00 pm | MC: Nicholas Coops

Shiva Zargar	Canada	Life cycle assessment of lignin-containing cellulose nanocrystals (LCNCs) isolation using deep eutectic solvents (DES)
Md. Habibur Rahman	Bangladesh/ Japan	Geographical Variations of Commercial Consumption and Supply of Woodfuel and its Alternatives in Northeastern Bangladesh
Debbie Pierce	Canada	The impact of land ownership and deforestation in the Colombian Amazon from 2010 to 2020 on the livelihoods of rural women
Md. Seikh Sadiul Islam Tanvir	Bangladesh	The soil quality of the world's largest refugee campsites located in the Hill forest of Bangladesh and the way forward to improve the soil quality

## Poster session (All-Conference) – Part 1 of 2 | 6:00 pm – 7:00 pm

<b>Lead author</b>	<b>Country</b>	<b>Title of presentation</b>	<b>Track</b>
Md. Seikh Sadiul Islam Tanvir	Canada/ Bangladesh	The soil quality of the world's largest refugee campsites located in the Hill forest of Bangladesh and the way forward to improve the soil quality	4.2. Climate change: Carbon sequestration
Gaurav Chand Ramola	India	Bio-ecology of longhorn beetle, <i>Xylotrechus basifuliginosus</i> (Heller, 1926) (Coleoptera: Cerambycidae), a borer of Kharsu oak ( <i>Quercus semecarpifolia</i> Smith) trees in Western Himalayan temperate forests in India.	4.3. Climate change: Insect outbreaks
Pavithra GM	India	Soil Organic Carbon stocks (SOC) and sequestration potential of Permanent Preservation Plots (PPP's) in wet evergreen and moist deciduous forests in Central Western Ghats of Karnataka, their sustainability and land use types	4.2. Climate change: Carbon sequestration
Gopal Shukla	Canada	Biomass and Carbon Storage in Gmelina arborea Plantation at Agricultural Landscape in Foothills of Eastern Himalayas	4.2. Climate change: Carbon sequestration
Krishna Kumari	India	Impact of climate change in Western Himalayas: A review study	4.4. Climate change: Seed transfer
Mei He	China	Current Status and Utilization of Plant phytoncides in Forest Therapy	5. Technology and Innovation
Yu'an Hu	Canada	Mechanical properties and Dimensional stability of Bamboo Fiber Composites for Engineering	5. Technology and Innovation
Riya Tudu Solanki	India	Status of Wood Identification in Eastern Zone of India	5. Technology and Innovation
Smriti Panwar	India	Potential threats upon sustainability of <i>Myrica esculenta</i> in north-western Himalayas and emphasis on its conservation strategies by implementation of scientific technologies through village communities.	5. Technology and Innovation
Tara Kumari	India	Productivity assessment of wheat ( <i>Triticum aestivum</i> ) and pea ( <i>Pisum sativum</i> ) under <i>Grewia optiva</i> based existing agrisilvicultural system in mid-hills of Central Western Himalaya, India	6.1. Conservation: Indigenous and community forestry (policies, products)
Swathi Balakrishnan	India	Adaptive Potential of Teak and its Implication on Design of Conservation Strategies in India	6.2. Conservation: Landscape level approaches
Digvijaysinh Rathod	India	How do low-cost in-situ soil moisture conservation measures impact ecosystem services in chirpine ( <i>Pinus roxburghii</i> Sarg.) forest?	6.2. Conservation: Landscape level approaches
Anita Tomar	India	Growth and Sustainability Through High-Density Plantation Management	6.3. Conservation: Conservation valuation
Remya Unnikrishnan	Canada	Machine Learning - a Prospective Approach for Raw Drug Authentication	6.1. Conservation: Indigenous and community forestry (policies, products)
Hariharan SV	Canada	Miyawaki Forest – a Feasible Way to Create Urban Forest	7.1. Urban Forests: Benefits

## Plenary (All Conference) – Keynote 7 and 8

7:00 pm – 8:00 pm | Introduction by: Lori Daniels

Kenneth Er	Singapore	The Science & Technology behind transforming Singapore into a City in Nature
Michael Norton	Canada	Strategic Directions Towards Building Resilience to Wildland Fire in Canada

## Concurrent session 2.2 Forest Education and Cooperation

8:00 pm – 10:00 pm | Chair: Peter Marshall

Guangyu Wang	Canada	Asia-Pacific Forestry Education Coordination Mechanism
M. Al-Amin	Bangladesh	Future of Forestry Education and Career in New Normal: Collaborations and Technology Interventions
Youqing Luo, Yu Lin	China	Online Forestry Education in the New Era
Rodney Keenan	Australia	The Evolution of forest education in Australia: from forestry to landscape and ecosystem management
Tyson Quan	Canada	Transforming Secondary Education In British Columbia
Joris (Xuan) Jun	Canada	Inclusion actions for international transfer students at UBC – case study: 2+2/3+2 transfer programs between UBC Faculty of Forestry and its partner universities in China
Wil de Jong	Japan/ Netherlands	A comparison of forestry continuing education academic degree programs

## Wednesday morning, August 18

## Plenary (All-Conference) – Keynote 9 and 10

7:00 am – 8:00 am | Introduction by: John Innes

Chris Quine	UK	Exchanging knowledge: reflections on improving communication
Suresh Chandra Gairola	India	Forests and Climate Change in India: Innovative Approaches for Carbon Sequestration

## 3-Minute Talk Challenge (All-Conference), Part 2 of 2

8:00 am – 9:30 am | MC: Nicholas Coops

Cut Augusta Mindry Anandi	Indonesia	Customary institutions as entry points for landscape governance: A study in Kapuas Hulu in West Kalimantan, Indonesia
Lubina P. A.	India	Sustainable management of timber bamboo plantations as a new promising 'climate smart forestry strategy' – a case study from India
Peter Thür	Switzerland	Early growth requirements of two central African timber species
Kamana Pokhariya	India	The legacy effect of land use land cover changes in forest types of Panna Tiger Reserve, Central India
Daniel Barker-Rothschild	Canada	The impact of drought-induced abiotic stress on the composition and valorization of Douglas-fir lignin

Angela Muthama	Kenya	Using Ecological Niche Modelling to determine the ecological requirements and geographical occurrence of <i>Phragmanthera</i> spp. a woody parasitic plant in Rift Valley ecoregion of Kenya
Kehinde Olagundoye	Nigeria	Development of Geospatial database for the permanent sample plots of <i>Tectona grandis</i> Lin. F plantation at the university of Ibadan, Ibadan, Oyo state. Nigeria.
Magdalena Jovanovic	Serbia	Conservation of Wild Pear ( <i>Pyrus pyrastrer</i> (L.) Burgsd.) in Protected Area "Kosutnjak Forest"
Alida O'Connor	Canada	Operationalizing landscape approaches in Ghana and Zambia

## Poster session (All-Conference) – Part 2 of 2

9:00 am – 10:00 am

<b>Lead author</b>	<b>Country</b>	<b>Title of presentation</b>	<b>Track</b>
Arabelle Hurlstone	Mozambique	Forest Recovery through Emission Capture	4.2. Climate change: Carbon sequestration
Keith Openshaw	United States	Biomass, especially woody biomass: an essential ingredient to satisfy parts of the Paris Agreement on climate change	4.2. Climate change: Carbon sequestration
Yawar Bhat	India	An account of genus <i>Oligosita</i> & <i>Pseudoligosita</i> (Chalcidoidea: Trichogrammatidae) Egg Parasitoids from Jammu & Kashmir (India)	4.3. Climate change: Insect Outbreaks
Elizabeth Racine	UK	An evaluation of a gender integration workshop in Irangi Forest, Kenya	4.5. Climate change: Communities
Oladele Amoo-Onidundu	Nigeria	Solar Energy Technology: Resorting to Renewable Energy for SocioEconomic and Ecological Development of Wood Industries in Nigeria	4.5. Climate change: Communities
Phillip Kihumuro	Uganda	A Policy and Institutional Analysis of the Constraints to Retaining Trees on Farms in Uganda	6.2. Conservation vs. Consumption: Landscape level approaches
Yaowaret Jantakat	Canada	Spatial Distribution Modelling of Tropical Forest Types using GIS-based Cluster Analysis	6.3. Conservation vs. Consumption: Conservation valuation
Christina Geng	Canada	Human-wildlife Conflicts in Banff National Park: Patterns, Trends and Implications	6.4. Conservation vs. Consumption: National park management
Miantsia Olivier	Cameroon	Multivariate analysis of cranial measurements of Cameroon's Blue Duiker ( <i>Cephalophus monticola</i> Thunberg, 1789)	6.5. Conservation vs. Consumption: Wildlife management
Abha Manohar K	India	Urgency of Conserving a Globally Vulnerable Tropical Medicinal Tree: <i>Saraca Asoca</i>	6.5. Conservation vs. Consumption: Wildlife management
Arun Pratap Singh	India	Butterflies Associated with Different Forest Types in Western Himalaya, India	6.5. Conservation vs. Consumption: Wildlife management
Yaowaret Jantakat	Canada	Supporting Role of Green University on The Spatio-Temporal Change of Tree Canopy Cover	7.1. Urban Forests: Benefits

Norgrove Lindsey	Canada	Urban trees can increase avian and insect diversity and abundance in tropical cities	7.1. Urban Forests: Benefits
Fangbing Hu	Canada	Resident perceptions toward tourism development: a case study from Grand Canyon National Park, USA	7.2. Urban Forests: Community engagement
Oyinlola Fasoro	Nigeria	Willingness of Ibadan Residents to Plant Trees to Commemorate Social Events	7.2. Urban Forests: Community engagement
Wagmare Balraju	India	Most Efficient tree species (Tree Ring) using for monitoring of urban, industrial pollution area, A review	7.3. Urban Forests: Valuation

Plenary: Conference Recommendations (All-Conference)

10:00 am – 11:00 am

20<sup>th</sup> Commonwealth Forestry Conference - Closing Ceremony and Farewell

11:00 am

## Abstracts of Conference Presentations

**All abstracts are arranged in alphabetical order by last name of (lead) author within a particular Conference session theme**

### Keynote presentations

#### The Future of Forestry – The Climate Change Challenge and Opportunity

Julian Elder

*Scion – Crown Research Institute, New Zealand*

Research and development is crucial to the future of forestry – both the risks it faces but also the opportunity. This is a sector where R&D plays, or should play, an essential role because what we plant today needs to deliver over a period of decades.

The talk will cover my perspective on why this is so important and what we are doing to try and develop compelling narratives to get all the key actors engaged in driving, not only the mitigation and adaptation needs resulting from climate change, but also the very significant opportunities that the global move to a circular bioeconomy offers. The premise is that this is going to involve all actors coming together to develop and commit to a direction over the long term.

#### The Science & Technology behind transforming Singapore into a City in Nature

Kenneth Er

*National Parks Board, Singapore*

As the result of greening efforts that have spanned more than 50 years, Singapore is one of the greenest cities in the world and home to a rich diversity of flora and fauna – all of this despite being a small city-state of 728 km<sup>2</sup>.

In this keynote presentation, Mr. Kenneth Er (Chief Executive Officer, National Parks Board, Singapore) will share about Singapore's ongoing transformation into a City in Nature to create a green, livable and sustainable home for all Singaporeans.

This City in Nature vision is anchored on a science-based approach to retain and integrate greenery, and also to restore nature into the urban landscape, in order to address the effects of urbanisation and climate change. This includes safeguarding nature reserves in core biodiversity areas, providing nature parks to buffer the reserves from edge effects and naturalising urban parks as supplementary habitats.

Ecological connectivity is further strengthened through an island-wide network of nature ways and park connectors, which involves the transformation of urban tree plantings into forest structures through the introduction of native trees in a tiered structure. Underpinning this effort is the translation of conservation science, urban ecology and forestry principles into planning and practice through the use of technology, digitalisation and analytical models. This has also enhanced the capacity to reach out and promote community participation and stewardship.

## Forests and Climate Change in India: Innovative Approaches for Carbon Sequestration

Suresh Gairola

*Forest Stewardship Council, India*

Forestry sector contributes significantly to global carbon dioxide (CO<sub>2</sub>) emissions, and at the same time provides significant mitigation and adaptation opportunities. With present forest and tree cover standing at 24.56 % of the geographical area, India is one of the few countries where it has increased in recent years transforming country's forests to net carbon sink owing to national forest policies aimed at conservation and sustainable management of forests. Nationally determined contribution of India under UNFCCC includes creation of an additional carbon sink of 2.5 – 3.0 billion tonnes of CO<sub>2</sub> equivalent through additional forest and tree cover by 2030.

The first forest carbon estimation in the country done in 2002-03 for the period 1984-1994 was 6071 million tonnes (mt), followed by 6663 mt in 2004 and 7125 mt in 2019. The annual increase of carbon stock is estimated 21.3 mt, which is 78.1 mt of CO<sub>2</sub> equivalent. Soil organic carbon is the largest pool (56.2%). The per hectare carbon stock of open forests is 59 tonnes per hectare and 85 tonnes per hectare for moderately dense forests.

Innovative initiatives like forest landscape restoration of 26 mha land under Bonn Challenge, sustainable forest management through National Working Plan Code, addressing drivers of deforestation and forest degradation, National REDD+ Strategy, combating desertification, devolution of compensatory afforestation funds to states, rejuvenation of major river systems through forestry interventions, intensive fire management, strengthening legal framework and societal engagement are set to achieve national goals and international commitments. This aims at improving productivity of national forests and expanding tree cover outside forests through the implementation of national policies.

This keynote presentation discusses these innovative interventions for increasing and monitoring India's carbon stock.

## Assisted migration and the reluctant acceptance of new forest interventions as a climate adaptation strategy

Shannon Hagerman

Robert Kozak, Guillaume Peterson St-Laurent, Ricardo Pelai, Ngaio Hotte, Veronika Gukova, Noa Mayer, Kieran Findlater

*Faculty of Forestry, University of British Columbia, Canada*

The use of assisted migration (AM) as a climate adaptation strategy in forests has passed an inflection point. No longer a tentative proposal, AM is becoming a reality in jurisdictions across Canada. While myriad uncertainties persist, pilot programs are now well underway, including in British Columbia (BC). Gaining a complete understanding of the effectiveness and feasibility of AM at scale requires not only a thorough comprehension of ecological impacts, but of societal dimensions as well.

We report on the findings across a five-year study which examined how publics, stakeholders, and end users think about the risks, benefits, and overall acceptability of AM. Our findings are based on datasets that include public and practitioner surveys, focus groups and cost-benefit analyses in four

forest-dependent communities, in-depth interviews, and document analyses. The results show resigned acceptance of the inevitability of increasing interventions in forests, with all of the groups studied being significantly less supportive of AM outside of natural range as opposed to within. Crucially, far more than the intervention itself, the risks that people are most concerned with revolve around who will deploy the technology, how decisions about its use will be made, and whether AM will merely perpetuate status quo models of forest governance that are not widely accepted. We discuss the role of knowledge politics in perpetuating the status quo, and how values about what is perceived as natural, and mistrust in managing authorities contributes to what can best be described as reluctant support for AM.

As a future of increased interventions seems all but inevitable, issues of knowledge, values, and trust require resolution. Accordingly, involving diverse perspectives at early stages of policy-making is essential to ensure that new technologies – like AM – address the broader needs of society, and not just a select few.

### University forestry education after the epidemic: Will anything change?

John Innes

*Faculty of Forestry, University of British Columbia, Canada*

Like many other similar disciplines, ‘forestry’ often reflects on its coherence as a discipline and its relevance to society. However, as a professional discipline, these ruminations are often initiated by people who have never been directly involved in forestry. This is a problem that has grown as forestry schools have diversified to try and maintain student numbers. Increasingly, the faculty members teaching students forestry have minimal or even no experience of managing a forest. Given that forests cover a third of the land surface of the Earth, this is becoming a significant issue. The problem is particularly apparent in forestry schools that have diversified to the extent that they are now called schools of ‘natural resources management’, ‘environmental sciences’, or a combination of forestry and something else, such as ‘forestry and conservation science’. The combination of forestry with another discipline is particularly insidious, and has inevitably led to the demise in the unit of forestry as a separate and unique discipline.

Forestry has a long and proud history, although courses addressing the history of the discipline is curiously absent from most university curricula. A direct consequence of this is that students are often unaware of the context of their discipline, and have little understanding of the basis of ethical requirements that may be taught. In good forestry schools, there is a focus on the acquisition of competencies – skills that individuals will need when they become foresters. These are diverse – ranging from surveying, to plant identification, to quantitative planning, to interactions with multiple and diverse stakeholders. Unfortunately, the requirements are so broad that there is little room for additional courses in areas seen by many as of marginal relevance. The better forestry schools also ensure that the learning experience is highly experiential, with students spending a considerable amount of time in the forest.

The earliest forestry schools were established in the late 1700s in what is now Germany. Through the 19<sup>th</sup> century, the number of forestry schools progressively increased, although it was not until 1878 that the first English-speaking school was established (the Imperial Forest School at Dehradun in

India, founded by Dietrich Brandis). The 20<sup>th</sup> century saw a rapid increase in the number of university forestry schools worldwide, but by the end of the 20<sup>th</sup> century, many forestry schools were in crisis, and saw mergers and closures. Much of this was related to a drop in the numbers of students, which precipitated the diversification described earlier.

In the early 21<sup>st</sup> century, further consolidation has occurred, and the number of schools has continued to shrink in some regions, and many of the remaining schools have struggled to survive. In 2020, the coronavirus pandemic hit the world, forcing major changes in how university education is delivered, with most programs having to switch to online delivery. This new form of teaching is very different to the hands-on training provided in the past, and initial thoughts were that it would be impossible to teach field skills online. However, it is clear that at least some skills can be transferred, and others may even be better taught online. Students however indicate a preference for in-the-forest training, and this will likely start again as the world returns to a post-pandemic normal.

There are however a number of changes that may have been precipitated by the pandemic. New forms of training are being offered, such as micro-certificates that may or may not lead ultimately to a degree. Intensive Master's programs are condensing the material from three- and four-year undergraduate degrees into a single year of highly concentrated learning. And new technologies, ranging from the control of drone swarms to the incorporation of Artificial Intelligence, are making their way into more progressive curricula. The future looks bright for those schools that can adapt to these changes. For others, partnerships and strategic alliances may be the answer, especially now that remote teaching has evolved to the extent that it has.

One thing is clear: today, the need for trained foresters is greater than it has ever been.

## Urban forestry and human health

Suzanne Mavoia

*Melbourne School of Population and Global Health, University of Melbourne, Australia*

Natural environments are important for human health and wellbeing. We know that being in, or even having a view of, nature can be restorative and therapeutic. In cities, urban forests provide these benefits, and can potentially support health in many other ways. For example, urban green spaces and overall levels of 'greenness' in cities have been linked to improved physical activity, birth outcomes, mental health, and cardiovascular mortality. Yet most studies on the relationships between urban forests and human health have focused on relationships between a few coarse measures of the urban forest such as access to green spaces and overall vegetation levels. To better inform the planning and management of urban forests and minimise unintended negative health consequences (e.g., via allergens, infectious disease vectors) we need to move beyond the existing evidence base to understand the multiple pathways linking specific elements of urban forests to human health.

This talk will provide an overview of current knowledge and recent research that is investigating under-explored mechanisms linking specific elements of urban forests (e.g., biodiversity, private/public areas, soils) with health. These mechanisms include the environment-human microbiome, vitamin D synthesis, allergens, and mitigation of environmental harms such as temperature, air and noise pollution. Ultimately these new research directions will better inform

urban forest design and management by answering key questions such as: What types of green space are beneficial to health? How much vegetation is needed, what type should it be, and where should it be located? What roles do biodiversity, soil and water play? And, ultimately, how can we best support the health of both urban forests and the people that live in cities?

### Urban forestry in the era of the Anthropocene: Science, education, action

Harini Nagendra

*Research Centre, Azim Premji University*

The era of the Anthropocene is also the era of the urban. This is especially apparent in the global South, where cities are on a breakneck path to growth. Urbanization has brought prosperity and promise, but also pollution, stress, and disease.

The role of urban forestry is ever more critical in the era of the Anthropocene to combat climate change, disasters and pollution, and create healthy, livable, happy cities. Drawing on my work on research, education and practice in Indian cities, I discuss why we cannot go back to the ecology of the past. Instead, we must look at how urban forestry plays out in the lives of contemporary and future cities to collectively reimagine and redesign a better urban future.

### Strategic Directions Towards Building Resilience to Wildland Fire in Canada

Michael Norton

*Northern Forestry Centre - Canadian Forest Service, Natural Resources Canada*

Climate change and other drivers have increased the frequency and intensity of wildland fire events in Canada. Three fires in the past five years have each resulted in costs over \$1 billion; the Fort McMurray fire (Alberta, 2016) alone resulted in costs of nearly \$7 billion. The need to strengthen Canada's resilience through evidence-based policies and practices is more important than ever. This presentation will provide an overview of the efforts Canada is making to address key knowledge and data gaps, to transform wildfire management to better manage risks, and to increase wildland fire resilience. Work is underway to answer important questions such as: What decision tools will assist in assessing wildland fire risk? How do we modernize and standardize technical systems? How do we enhance Indigenous fire knowledge and partnership? There is an increasing need for Canada to enhance prevention and mitigation activities through a whole-of-society approach given that wildland fires are not solely a forest management issue. Global collaboration is critical to strengthen national research capacity, to deliver targeted outputs, and to reduce the impacts of wildland fires on society.

## Exchanging knowledge: reflections on improving communication

Chris Quine

*Forest Research, United Kingdom*

Successful protection and sustainable management of forests in the light of the multiple challenges now faced will require strong linkage between science and practice.

Yet often there is perceived to be a gulf between knowledge and action. Drawing on recent studies, I will share some reflections on research communication, the importance of knowledge exchange and how interactions between researchers and practitioners might be improved.

## Legacy from the 19th Commonwealth Forestry Conference and looking forward to the future of forests

Dr. Savita

*Forest Force (PCCF HoFF) of the state of Himachal Pradesh*

*Please watch this presentation on the virtual platform.*

## Special session: Building Our Future

### Sustainable material developments with bamboo

Chunping Dai

*Faculty of Forestry, The University of British Columbia*

Bamboo is one of the fastest-growing plants on the planet. Used since ancient times as a food, fuel and materials, bamboo is becoming increasingly important as a sustainable solution to a number of pressing global challenges, including poverty, climate change and timber shortage. This presentation will highlight some of the research work by UBC's newly established Bamboo Application and Management (BAM) Group and its partners. We will discuss bamboo's unique growth and carbon sequestration attributes, and opportunities and challenges of current engineered bamboo products for building applications. Examples of innovative bamboo-based products for bio-packaging and green infrastructure applications will also be presented.

### Recent Trends in Building with Wood

Ian de la Roche

*Forest Resource Management, Faculty of Forestry, University of British Columbia, Canada*

Population growth, increasing urbanization, geophysical and climate-related disasters are just some of the mega-trends impacting a growing global demand for affordable shelters.

Environmental sustainability, carbon footprint, new technologies and innovations throughout the wood construction value chain are driving a renewed interest in wood, particularly when used in combination with other mainstream building materials.

This presentation will examine these current trends, with particular emphasis on sustainability, emerging technologies, new wood products, new applications and new business models which are all helping to optimize the wood construction value chain. The author will conclude by offering his perspective on the critical role which wood can play in meeting the construction needs of the future.

### Beyond the Case for Tall Wood

J. Eric Karsh

*Equilibrium Consulting Inc., Canada*

Ten years after we made "the Case for Tall Wood", it is clear that the concept has taken deep roots. We no longer argue whether Tall (and Big) Wood is possible or even a good idea.

The challenge before us now is to identify the best most repeatable large scale timber solutions, in the same way that the steel and concrete industry settled on their own go to solutions over time.

As lessons learned continue to accumulate from a fast growing pool of market driven projects, those go to timber solutions are bound to come into focus. This presentation will take stock of the state of affairs today.

## The Evolution of Mass Timber Construction at the University of British Columbia

John Metras

*University of British Columbia, Canada*

This presentation provides an overview of mass timber building construction at the University of British Columbia (UBC) over the past decade. UBC has been at the forefront of the revitalization of wood construction with the innovative use of mass timber products in academic, student life and operational buildings. A total of nine building projects at UBC have utilized engineered wood products in significant structural applications during this period, with another building currently under design. A wide range of products have been deployed including glue-laminated timber (glulam), cross laminated timber (CLT), parallel strand lumber (PSL), laminated strand lumber (LSL), and nail laminated timber (NLT). Lessons learned on initial projects with respect to design, construction methodology and cost informed the development of subsequent projects. This evolution culminated with the Brock Commons Tallwood House, an 18-storey (54 metre) student residence which at the time of completion in 2017 was the tallest hybrid mass timber building in the world. The presentation will review the benefits, challenges, and key lessons from these mass timber projects.

## Growing the Future

Michael Ramage

*Department for Research, University of Cambridge, United Kingdom*

Cities need to go on a vegetarian diet — we can build most of the buildings we need from plant-based materials. Timber skyscrapers are possible, and large scale housing, schools, hospitals and other mid-rise buildings have a large role to play in carbon storage in long-lived real assets. Forest conservation and timber construction can be symbiotic. The buildings are beautiful, energy efficient, and resilient. We need policies to ensure widespread adoption around the work.

## Building with Bamboo

Neil Thomas

*Atelier One, United Kingdom*

George Bernard Shaw once said, “there are those men who look at the world as it is and ask “why?”, while there are those men who look at the world as it might be and ask, “why not?”

Atelier One’s introduction to Bamboo: After a visit to Bali 10 years ago, I found people “back home” thought building with bamboo was a bit of a joke.

Engineering investigation into Bamboo: However, it is important to understand the very precise structural properties of Bamboo from the Molecular level up as only nature could have made something quite so beautiful.

Assessing the potential of Bamboo including form and connection: Working with Ibuku in Bali to enhance our understanding of Bamboo’s remarkable properties with years of work on geometric shape and stiffness

Laminated Bamboo: We are at the birth of a novel material (laminated bamboo) that can be used by the construction industry. Although in its infancy, it will compliment wood as a sustainable building material.

Online Bamboo: A plea- let's form an open source, online resource.

The Arc: A recently completed project applying some of what we have learned.

The builders asked when are we putting the trusses in!!!!

### Special Session: Forest Stewardship Council

#### New forest-based products – Textile sector in Asia

Cindy Cheng

*Forest Stewardship Council - Asia, Hong Kong/P.R. China*

Forest-based textiles, such as rayon, viscose, modal or lyocell are increasingly being used in the fashion industry. If cellulose fibres come from well-managed forests they can be more environmentally friendly than synthetic fibres, such as nylon or polyester, or even natural fibres, such as cotton. In this session we will share some of the successes and opportunities around forest-based textiles.

#### Leadership in caribou conservation through voluntary certification

Francois Dufresne

*Forest Stewardship Council, Canada*

The impact of forest management practices on Species at Risk, specifically boreal woodland caribou, is an issue of significant concern in Canada. Populations of woodland caribou are at varying degrees of risk and are particularly sensitive to habitat disturbance. As a result, the Forest Stewardship Council (FSC) Canada has drafted an indicator dedicated entirely to boreal woodland caribou in our National Forest Management Standard. With the new standard effective as of January 1, 2020, several FSC certified companies have now been assessed to the caribou requirements. Drawing from the experiences of early implementation of the requirement and audit results, we will share examples of lessons learned, and the challenges, successes and opportunities of implementing the requirement.

## Delivering Nature Based Solutions through forest certification, ecosystem services and restoration

[Pina Gervassi](#)

*Forest Stewardship Council, Peru & Germany*

Within the FSC system Nature Based Solutions are delivered across three landscape related actions. (1) Forest certification provides a market mechanism and framework to deliver sustainable forest management while newer mechanisms provide additional benefit. Ecosystem Services (2) expands and leverages benefits across areas like water and soil conservation, biodiversity and climate mitigation, providing a verification structure and associated claim and (3) enhanced Restoration creates needed benefit, especially as it relates to climate mitigation and biodiversity. In this session we will explore how a multi-faceted landscape approach creates broader solution spaces and opportunities for integrated and prioritized investments and outcomes. We will share examples about carbon markets, and other ecosystem services.

## Using FSC forest certification to promote and incentivize restoration in Africa

[Harrison Ochieng Kojwang](#)

*Forest Stewardship Council – Africa, Kenya*

Various initiatives call for massive restoration of the degraded forests of Africa; the Bonn Challenge and AFR100, as an example. Restoration is expected to happen at all scales, from the isolated forests and woodlands on farms to large scale afforestation programs. To that extent Africa will need to attract investments, both public and private to meet its restoration goals. As such, FSC has an opportunity to strategically position itself by expanding its framework through the development of restoration requirements that would allow restored landscapes to be certifiable. As global leaders, FSC can play a role by working with organizations across the commonwealth to encourage financing institutions to support restoration in Africa.

## FSC's Global Strategy

[Alan Thorne](#)

*Forest Stewardship Council, Canada*

The FSC Global Strategy 2021-2026 was approved by the FSC International Board of Directors and launched in December 2020. The new strategy sets the direction and the intended outcomes for FSC within the next 5 years, while building a path towards the 2050 Vision of resilient forests sustaining life on earth.

The strategy positions FSC as a global leader contributing to solutions to the world's major forest challenges including climate change and biodiversity loss. Building on FSC's core strength of being a community for co-creation, it aims to create momentum towards the 2050 vision through certification and work in alliances. The strategy emphasizes the vital role of forest stewardship, including sound efforts towards protection, conservation and restoration as well as active management for forest products and services.

The 2026 objective sets as ambition the demonstration of the value and benefits of forest stewardship in 300 million hectares of FSC certified area, of which 50 million hectares are natural tropical forests and areas managed by smallholders.

### Session 1. New Markets and Applications

#### The impact of drought-induced abiotic stress on the composition and valorization of Douglas-fir lignin

Daniel Barker-Rothschild

*Canada*

3-Minute Talk

Embedded in the complex three-dimensional supramolecular structure of the secondary plant cell wall, lignin is a phenolic biopolymer proposed as a renewable and sustainable source of energy and materials. Lignin has been conventionally considered a waste stream in the pulp and paper industry and burned as a low value fuel. Recently, lignin valorization has become an important area of research involving both upstream and downstream approaches as well as “lignin-first biorefineries” that primarily focus on the upgrading of lignin for different practical applications and new markets. A wide variety of lignin-based products and applications have been proposed, such as alternatives to petroleum-based chemical products, thermoplastic and thermoset polymer composites, carbon fibres, nanomaterials, wastewater treatment, and drug delivery. Our team has investigated the molecular-scale response of Douglas-fir to drought-induced abiotic stress to assess changes in the composition and value of lignin as a renewable resource for the production of biofuels and high-performance materials. Lignin has been isolated from the outer rings of Douglas-fir seedlings grown under normal and severe drought conditions using a modified organosolv extraction technique performed at atmospheric pressure. The lignin samples have been characterized by a series of analytical methods, including nuclear magnetic resonance, infrared spectroscopy, and pyrolysis followed by gas chromatography-mass spectrometry. Chemometric approaches have been applied to the resulting analytical data to elucidate the structural and compositional changes related to drought. The findings contribute to the development of the bioeconomy by understanding the changes in the value of wood as a source of renewables in the conditions of drought and evaluating the potential of lignin to replace petroleum-based fuels and materials.

#### Accelerated Growth in Non-Timber Forest Products Based Bioeconomy for Income Enhancement and Poverty Eradication in India and its Future Trajectory

Dr Bala Prasad

*Indian Forest Service (Ret.), Forest Force, Manipur, India*

The value of non-timber forest products (NTFPs) removed annually from of Indian forests, largely by the poorest communities, is estimated at US \$ 300 billion in raw form without processing. Due to accelerated growth in demand many species of NTFP have developed their own niche in the domestic and international markets. The processing and marketing in the inter-related sub-sectors including traditional medicines, herbal nutraceuticals, functional foods, phytochemicals, cosmetics, herbal teas, flavours and fragrances, aromatherapy, culinary herbs and spices, and veterinary herbal

products industries, add 7-10 times by way of value addition that get further enhanced in case the product has an export market. A series of developmental initiatives in activities related to sustainable collection, resource augmentation, processing and marketing of NTFPs, including through Joint Forest Management, Forest Right Act, National Medicinal Plants Board and Minimum Support Price to NTFPs, have inter alia contributed substantially to reduction of poverty with the incidence of multidimensional poverty almost halved in the decade ending 2015-16 from 635 million people to 364 million. The author presents a detailed analysis of the current status and trend of India's NTFPs based bioeconomy and a road map for sustaining and accelerating the growth for income enhancement and eradicating poverty and therefore, integrating NTFPs into bioeconomy is critically important for India and similarly placed countries, and needs to be appreciated in larger perspective.

*Key words: NTFP, bioeconomy, minimum support price, poverty eradication, income enhancement*

**Which financing strategies can unleash forest-based industries engagement for ecosystem restoration?**

Ludwig Liagre

Dr. Lyndall Bull, Sven Walter

*Canada*

The forest-based industries create tens of millions of jobs globally and production forests represent more than 25% of total forest area (FRA, 2020). Forest-based industries are major players in forest products value chains. The sector's success involves multiple small and medium enterprises, land owners and smallholders, thus making forest-based industries one of the pillars of rural development and enabler of the transition to a circular bioeconomy.

The UN Decade on Ecosystem Restoration (2021-2030) aims to prevent, halt and reverse the degradation of ecosystems. Beyond the environmental and social benefits ecosystem restoration brings to society, engaging in ecosystem restoration also has a strong economic rationale.

Some forest companies are engaged in ecosystem conservation and restoration. Despite this it is our understanding that no forest-based industries are official partners of ecosystem restoration initiatives and commitments. In the context of the UN Decade on Ecosystem Restoration, the article identifies the drivers for forest-based industries engagement in ecosystem conservation and restoration. Based on case study analysis and a series of interviews with forest companies' leaders, the research focuses on the financing approaches and strategies that the private forest sector has developed to mobilize resources for ecosystem conservation and restoration. Drivers identified in our research form a virtuous circle through: increased available biomass and forest products; improved market access and product value with sustainable certifications; risk mitigation measures and avoided costs; alternative revenue streams including from the valorization of forest ecosystem services; commitments to sustainability in value chains; and sustainable finance mobilization, for example through corporate green bonds.

The article highlights how good practices of ecosystem services valuation, disclosure of climate and nature related risks and the design of relevant financing instruments and mechanisms (such as forestry funds) may represent catalyzers for the contribution of forest-based industries for ecosystem conservation and restoration.

## Micromorphology and phytochemical screening of *Anthocleista djalensis*

Abosede Mustapha

Samuel Oluwalana

*Nigeria*

Medicinal plants are of significant value in the health of rural and urban populace. This study assessed the medicinal uses, phytochemical composition and micromorphology of *Anthocleista djalensis* bark in southwest, Nigeria. Plant barks as one of the ecosystem benefits reveal the interaction between the individual and environment and their health consequences. In contrast to public health and intention to reduce human mortality and morbidity; increasing the health care of the populace, recent clinical medicine has its limits. The chemicals/ minerals always function alone or in conjunction with one another to produce the desired pharmacological effects. Plants communicate with their external environment, protect and maintain essential internal physiological and biochemical processes through specialized epidermal structures. Advances in microscope technology and improvements in Scanning Electron Microscope-SEM and Electron Display X-ray-EDX have increased the accuracy and capabilities of microscopy as a means of herbal medicines identification and reliable authentication. This will create awareness on the authenticity and safety of medicinal plants (barks) promoting the wellbeing of the community and combating challenges of saving lives and health. Morphological studies of medicinal plants are crucial in order to ensure safety and standardization of herbs. SEM revealed deposition of pores and crystals in the inner layer of the bark. Microanalysis revealed the enrichment of the bark with C, O, S, Ca and K observed to be more prominent. Phytochemical contents such as alkaloid and phenols in the bark analysed, contributing to scientific advancement in knowledge to the acclaimed health significance in the treatment and management of diseases as well as its uses as spices. This emphasized the reason and synergism in the medicinal plant barks in herbal therapy knowing that human needs depend on ecological services that have previously depleted but resuscitated sustaining use of natural resources, promoting economic development and curbing adverse effect on ecosystem.

## Monitoring of Eco-biophysical dynamics using time-series MODIS data on GEE platform: A case of the Aravalli hills range (India)

Alok Raj

Laxmi Kant Sharma

*India*

In the Indian semi-arid climatic zone, the Aravalli hills range is an ecotone between the Thar desert and Gangetic plain, covering ~10% forest cover of India's western part. This range has encountered substantial areal transformation in the last five decades. However, we claim that the forest greenness enhancement has occurred discontinuous degradation within the entire range, without geographical alteration. The current study uses MODIS Products to compare and contrast spatiotemporal eco-biophysical parameter-based ecosystems services dynamics between different sub-ranges (upper, middle, and lower) of Aravalli between 2000-2019. This study used seven eco-biophysical parameters for this analysis: EVI, LAI, PTC, PNTV, ET, NPP, and LST. The pixel-based time-series trend evaluation for MODIS imagery composite within GEE platform using the ordinary least square (OLS) regression

method identified that forest enhancement is happening in some part of different ranges. Based on the analysis, ecological health in 2009 was low and in 2001 high, while NPP after 2009 to 2019 varying. The northeast part of the upper range and southwest of the lower range shows a significant change rate in PTC, EVI and LAI while PNTV is nominal. Forest protected areas in the Aravalli range have not considerably changed; however, the substantial impact is evident in the western edge of the Aravalli range. We have reported certain human-induced factors and natural stressors which could be responsible for observed forest health dynamics, which trigger to disturb the ecosystem health services of the range. We have suggested sustainable planning and policy makeover alternatives for those under anthropocentric stress to help management practices.

### Economic values of ecotourism of selected natural sites in Southwest Nigeria

Jubril Soaga (2),

Lukmon Dawodu (1), Michale Shittu (1), F Ashaolu (1)

*(1) Department of Agricultural Economics and Farm Management, (2) Department of Forestry and Wildlife Management, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria*

Ecotourism is responsible travel to natural areas involving conservation and better welfare of local population. This study analyzed the economic values of ecotourism in selected natural sites in South-West, Nigeria. Multistage sampling technique was used to select 247 respondents consisting of 124 resident neighbours (RN) and 123 visiting tourists (VT) from 3 selected sites: Olumo Rock; Erin-Ijesha Waterfalls and Oniru Beach. Data were obtained through the use of questionnaire to describe respondents' demographic characteristics, estimate of current economic value of sites, willingness to pay (WTP) for improved services by tourists and factors affecting their WTP. Data were analyzed using descriptive statistics, on-site individual travel cost method (ITCM) and Poisson regression. Results reveal that 80.8% of RN and 64.2% of VT were married, 54.2% of RN and 65.0% of VT were male with mean ages of 42 years (RN) and 38 years (VT), average household size of 5 members (RN) and 4 members (VT) as well as mean monthly income of N66,166.67(RN)(C\$222) and N112,916.67(VT)(C\$379). Monetary estimates calculated for current recreational values of the selected natural sites were N271.87 (C\$0.91) per tourist and aggregate value of N30,646,817.62 (C\$102,842) per annum. Result shows that the mean and annual WTP values for improved services was N304.67(C\$1.02) and aggregate of N34,344,230.42 (C\$115,249). Monthly income ( $p < 0.01$ ) and citizenship status ( $p < 0.05$ ) were factors influencing WTP for improved services. Suggestions include infrastructural amenities along with sanitation facilities be upgraded. Entrance fee should be reduced to reflect tourists WTP value. Service delivery at the sites should be improved to harvest the huge financial benefit accruing from the sites. Programmes that would attract influx of high-income earning tourists and those that are indigenes of communities of the sites should be encouraged to improve monetary benefits through adequate recreational policy implementation.

*Keywords: Ecotourism, Natural sites, Resident neighbour, Visiting tourist, Recreational values*

## Life cycle assessment of lignin-containing cellulose nanocrystals (LCNCs) isolation using deep eutectic solvents (DES)

Shiva Zargar

Jungang Jiang, Feng Jiang, Qingshi Tu

*Canada*

3-Minute Talk

Recently, deep eutectic solvent (DES) attracted great interest in isolating nanocellulose owing to its distinct advantages of biodegradability, low toxicity, and recyclability. Lignin-containing cellulose nanocrystals (LCNCs) obtained using DES pretreatment showed an improvement in the performance of nanomaterials production. The environmental assessment of innovative processes is critical to improving the efficiency and sustainability at the design stage. Hence, this study evaluates and compares the environmental impacts of LCNCs production from the thermomechanical pulp (TMP) following acidic DES pretreatment (binary system of “choline chloride – oxalic acid dihydrate” or ternary system of “choline chloride – oxalic acid dihydrate – p-toluenesulfonic acid”). The evaluation was conducted through a cradle-to-gate life cycle assessment adopting TRACI [v2.1, February 2014] for evaluating global warming potential (GWP) and acidification potential (AP) impact categories, and the Cumulative Energy Demand [v1.0.1, January 2015] LCIA method for energy use (MJ). The average GWP, AP, and energy use were 34 kg CO<sub>2</sub>-eq, 0.15 kg SO<sub>2</sub>-eq, and 919 MJ per kg LCNCs, respectively. The sensitivity analysis showed that different degrees of reduction in environmental impacts could be achieved by varying the input volume and/or reuse frequency of DES solutions. The largest reduction in GWP, AP, and energy use was achieved by reducing the input volume of DES solutions to 20% of its default value.

## Session 2. Forest Education and Careers

See also Keynote: [University forestry education after the epidemic: Will anything change?](#) – presented by John Innes

### 2.1. Forest Education in the Context of Massive Transition

#### The role of forest education in shaping the workforce of the future

Alicja Kacprzak

*United Nations Economic Commission for Europe, Food and Agriculture Organization of the United Nations, UNECE/FAO Forestry and Timber Section, Italy*

*Keynote presentation for this session*

Over the past few decades, forestry has undergone significant structural and organizational changes, from large corporate structures to sectoral fragmentation and the outsourcing of work to contractors. Also, an increased competition among different expectations for forest functions and the rise of ecological awareness impacted forest management objectives. Forest work evolved from the extraction of natural resources to conservation and management of forest ecosystem services.

Today, there is an increasing number of professionals working in biodiversity conservation, landscape management, forest monitoring, certification and education. It is these professions that will play a key role for the future of forests and the forest sector.

Forest workforce of tomorrow will build on innovation, rural and urban connections, links with science and technology as well as equal opportunities for women, young people and minorities. This requires adaptation of long-term education plans, based on assessment of skills needs and, above all, it entails fostering greater understanding of forests and forest careers among youth already in primary and secondary education.

The presentation will introduce key transformation drivers which will have an impact on the future of the forest work, such as climate change and sustainability, changes in global demographics, technology development and changes in work organization. It will also identify new job opportunities resulting from these trends as well as tasks and skill needs related to them. Finally, it will suggest immediate action points which can strengthen forest education, capacity development and knowledge sharing in order to attract and guide qualified workforce of the future.

#### Appreciation of Forestry Profession amidst Forestry and Wildlife students in Some Nigerian Universities

David Oriabure Ekhuemelo

*Department of Forest Production and Products, Federal University of Agriculture Makurdi, Nigeria*

This study assessed the appreciation of Forestry profession amidst Forestry and Wildlife students in some Nigerian universities offering Forestry program with the aim of evaluating future prospect of forestry profession and practice in Nigeria. Google Form online questionnaire was employed to elicit information from students from more than twenty universities from October 2020 to March 2021. Results revealed that total of 873 students from nineteen universities and others responded to the

questionnaire of which 57.4% were males and 42.6% females with ages below 20 years (14.5%), 21 – 30 years (78.2 %), 31 – 40 years (5.2%) and above 40 years as 2.1%. The respondents were in 100 level (6.3%), 200 level (18.2%), 300 level (29.3%), 400 level (14.4%) 500 level (12.7%), on national Youth Service Corps (2.7%) and graduates (16.4%). Majority of the students (85%) were single, 7.2% in marital relationship and 7.0% married. Respondent reported that students' enrolment in Forestry and Wildlife in Nigerian universities is increasing (81.6%), constant (10.3%) and decreasing (7.8%). Although 72.6% of the students did not chose reading Forestry and Wildlife at the university, 76.3% were satisfied reading the course, 71% agreed to go for higher degrees in the profession. For better study of the course, respondents claimed they do not have sufficient facilities (43%), no adequate classroom and laboratories (51.1%) while 62.8% agreed they have sufficient lecturers. Most (67.2%) respondents envisaged lack of job opportunity in Forestry profession as a major restrain from studying the course, 15.1% do not care about any challenge, 11.6% believe Forestry and Wildlife studies is not relevant in the modern world while 6.1% claimed they do not like the course. Result further showed that if given a new opportunity to choose a study, majority (36.0%) of respondents preferred Forestry and Wildlife program, 17.8% medicine/pharmacy/medical courses and 10.5% Agriculture/ Agribusiness. It was concluded that increasing number of Forestry and Wildlife students would develop more interest in the profession and practice if adequate facilities and job opportunities are provided.

*Keywords: Career, Forestry and Wildlife, Nigeria, students, university*

## Forestry Education in 21<sup>st</sup> Century: Trees to Global Socio-Ecological Systems

Shashi Kant

*Institute for Management & Innovation, and Institute of Forestry & Conservation, University of Toronto, Canada*

Forestry education has moved from trees to ecosystems and sustained timber yield to sustainable forest management during the last three decades. However, it is still dominated by timber production and ecological aspects of forests; other ecosystem services and their contributions to human wellbeing are treated like a pathological specimen in a labelled demonstration jar that is paraded in front of forestry students as an anomaly/exception. The Millennium Ecosystem Assessment brought the role of all ecosystem services in human wellbeing to the forefront and provides the direct evidence of an immense potential of forests to contribute to many Sustainable Development Goals (SDGs), including Clean Water, Climate Change, Education, Energy, Equity, Hunger, Human Health, Poverty, Sustainable Cities and Communities, and Economic Growth. However, the realization of this potential is possible only through the transformation of forestry education from trees to global systems. The main features of this transformation will include: (i) moving from trees to global socio-ecological systems; (ii) not treating ecosystem services other than timber as pathological specimen; (iii) moving from compartmentalized and narrow disciplinary thinking to critical, systems, and inter and trans-disciplinary thinking that draws upon, but also moves across, traditional academic fields and disciplines such as natural science, social science, and humanities; and (iv) promoting the wellbeing of all global human generations, maintaining healthy ecosystems, and fostering regenerative relations between natural, human, and technological systems throughout the globe. New technologies and collaborations across the globe will play a critical role in this transformation.

## TRANSFOR-M (TRANSatlantic FORestry Master): a Canada-Europe award-winning dual-degree Master program for training globally-minded forest and environmental managers and scientists

Brigitte Leblon

Heinrich Spiecker, Jorma Neuvonen, Marjoriitta Möttönen, Andreas Hamann, Paola Gatto, Sopan Patil, Kyrill Sattlberger, Raffaele Cavalli, Georg Gratzner, Margarita Calderon-Peter, Jasen Golding

### *Canada*

Under the leadership of the University of New Brunswick and of the Albert-Ludwigs-Universität, a consortium made of three Canadian universities, i.e., the University of New Brunswick, the University of Alberta, and the University of British Columbia, and five European universities, i.e., Albert-Ludwigs-Universität (Freiburg, Germany), Bangor University (Wales), University of Eastern Finland (Finland), University of Natural Resources and Life Sciences (Vienna, Austria) and Università di Padova (Italy) sought to address the following scientific and pedagogical challenges in the training of the next generation of natural resource managers and scientists:

- (i) Highlight the global importance of environmental issues by exposing students to a variety of regional and local solutions in a multicultural context.
- (ii) Educate students on cultural, historical, and economical diversities that exist in the Canadian and European natural resource sectors; and
- (iii) Increase employability of these students.

These challenges were addressed through TRANSFOR-M (TRANSatlantic FORestry Master), the first Canada-Europe dual-degree Master's program in forest and environmental management. TRANSFOR-M won an international award in 2014 for the most innovative graduate program.

As detailed in Leblon et al. (2013), this 2-year program draws from the existing expertise across the eight institutions through a blended practical and theoretical approach. The 174 students who enrolled in the program since 2011 have been offered unparalleled opportunities and experiences. The courses they take are credited toward the program requirement of both the home and host universities. The program language is English, but the students are invited to follow a second language course while being in Europe. Many students can also gain practical work experience at both the home and host countries.

Building and managing TRANSFOR-M requires extensive time and effort due to the different policies and procedures in each institution. However, the benefits realized far outweigh these challenges.

## Future Specialized Forestry Education for Africa

August Temu

Aissetou Yaye, Shabani Chamshama

*Tanzania and Niger*

Most of Africa's professional forestry education programmes were initiated between 1965 and 2000. During the seventies and eighties there were major influences arising from the recognition of the rising human demands for wood and non-wood products. Agroforestry emerged as an opportunity to merge profitability with ecosystem sustainability on farmlands and also to restrain slash-and-burn agriculture. Beginning in the nineties, larger issues on biodiversity, climate change and the threat of desertification emerged, bringing about major changes in forestry curricula. Currently, forestry has moved from the periphery to the centre of human livelihood and environmental sustainability. This paper cross-examines Africa's state of forestry education with a focus on transformations that can fulfil our future needs.

Over the years, the general trajectory of forestry education in Africa has been to 'graft' every new idea onto the existing curricula, without much change in the objectives or study period. This approach resulted in curricula that are jammed with topics that are superficially taught. The resulting graduates have challenges generating and apply the science and innovations needed. With regard to research, recent publications on forestry show a trend from hard science to greater social, economic and especially gender perspectives. Real forest science is fast disappearing! The African Forestry and Wildlife Commission at its meeting in March 2020 called for reform in forestry and wildlife education. Recent global developments indicate inseparable links of forestry to many aspects of livelihood including land, agriculture, environment, water, food, energy, wildlife, tourism, minerals and urban development. Major changes in African forestry education including expansion into several forestry-related degree programmes are needed in order to address our future needs. We envisage Agroforestry, Urban Forestry, Biodiversity Management, Forests and Livelihoods, Wood Science and Technology as new degree programmes that can be delivered by extending the duration of current programmes to allow for specialization.

## Forest Education in An Online Environment: Lessons Learned during the COVID-19 Global Pandemic at UBC

Michelle Zeng

*Faculty of Forestry, University of British Columbia*

This presentation reviewed the forest education at the University of British Columbia (UBC) during COVID-19. Before the pandemic, the use of digital tools in forestry courses was at a basic level without fully integrated with pedagogies or course design. Although we have an award-winning SFM online program, the online teaching and learning in credit programs were not fully explored in the Faculty of Forestry. As the pandemic challenged in-person teaching, tremendous efforts were made for a smooth online transition. Financially, UBC provided a significant amount of funding to employ numerous support staff and to support the use of advanced equipment (e.g. AR, VR, 360° camera). Administratively, an academic committee was formed to steer the transition and generate faculty-level guidelines and policies for online teaching. Operationally, a teaching and learning support unit

was established in the Faculty to support various tasks, including learning technologies, course redesign, and experience sharing workshops. Various digital tools were integrated to enrich course discussions, labs (e.g. 3D models, virtual field videos), and assessments (e.g. interactive quizzes, natural journal assignments). The Faculty's online teaching and learning experience was also examined every semester through student and teaching community check-in surveys. Overall, the survey participants were satisfied with the available support and students' academic performance. Yet, the level of students' engagement and motivation need to be further improved. As different teaching practices can have different effectiveness in meeting learning objectives, they should be adopted based on the course structure, learning objectives, class sizes, students' accessibility, and geographic regions. The various needs of students, staff, and teaching communities should also be well accommodated. Moving forward, we foresee that future courses will be more in a blended model that combines in-person instructions with online learning activities. Therefore, we suggest maintaining funding for sustained development and operation in enhancing the quality of forest education at UBC. Within the Faculty, an institutional culture that values innovation in both learning technology and pedagogy should be constructed. Adequate and timely support in learning technologies is also needed. Further research should investigate the means of using technology to improve the equity, accessibility, diversity, and inclusion of our future teaching.

## 2.2. Forest Education and Cooperation

### Future of forestry education and career in new normal: collaborations and technology interventions

M. Al Amin

*Institute of Forestry and Environmental Sciences, University of Chittagong, Bangladesh*

Forestry education is passing a paradigm shift from normal to new normal situations with its colonial approach to user friendly mode incorporating concepts of collaboration and technology interventions, leads to examine current job markets, corporate mechanisms to cope major challenges of climate change and resource sustainability. This talk also focus on the demand of new arena of knowledge of science, social science, technologies particularly artificial intelligence to manage vulnerable forest resources and also illustrates how to cope global change, biodiversity conservation, forest-people conflict, landscape level restoration, invasive species management, carbon trading, panel wood and wood processing to lead a professional forestry graduate. However, world is now passing a horrifying situation due to COVID19 pandemic. Students are one of the most distressed section of the society whose academic programs were seriously disrupted in person, like Bangladesh, yet to start in classrooms, chose to consider online platforms. 'Problem converts into opportunity' may be a good move to withstand the challenge. This discussion also illustrates how a bridge between forestry education of developed and developing nation is founded using on line platforms, lead to minimize the knowledge gaps and sharing technologies to build a standard curriculum on forestry in global scale, the collaboration outcomes of APFECM, a successful initiative of online study, set examples of sharing knowledge between stated nations lead to generic forestry education equity in the world, step forward to fulfil SDG 4 (quality education for all) and extends the job markets from national to global scale. Forestry students were always in front line for any positive change, able to take the new normal challenges, are well fit to build their career in mitigation, adaptation programs

of climate change, biodiversity restoration, wildlife management and above all, programs set for fulfilling SDG around the world.

### **Inclusion actions for international transfer students at UBC – case study: 2+2/3+2 transfer programs between UBC Faculty of Forestry and its partner universities in China**

Joris (Xuan) Jun

*Faculty of Forestry, University of British Columbia, Canada*

The 2+2/3+2 transfer program has been one of the most successful collaborations between the UBC Faculty of Forestry and the Chinese forestry universities. It offers opportunities for undergraduate students to transfer from a Chinese partner university to UBC. During their first 2-3 years study in China, students learning is monitored by various factors such as academic performance, leadership and innovation, and communication skills. Students will need to meet UBC's admission requirements prior to transferring to one of the forestry programs at UBC. To help students understand the learning culture and classroom dynamics, faculty members from UBC have traveled to China to provide in-person teaching sessions. With the increasing number of 2+2/3+2 students, the Faculty has noticed the growing need creating an inclusive environment for those students. A summer orientation program was established in order to help incoming students become familiar with forestry issues locally, adjust to new campus life, and promote academic integrity. For helping students blend into the existing student body, many social events were organized for cross-cultural understanding. Bootcamp style courses have been provided to help transfer students gain field work experience and enhance work safety in the field. Student performance during senior years at UBC has been monitored by course instructors, transfer program manager, academic advisors, and supervisors (if students choose to participate in certain internship or Co-op program). Weekly and monthly follow-up meetings have been very helpful for administrators to understand students' struggles and provide support in a timely manner. Through different evaluation systems, outstanding students have been granted with various scholarships in recognizing their achievements. The Faculty has also stayed connected with the 2+2/3+2 alumni to get feedback from their post-graduate learning and working experiences, find different ways to improve the existing programs, and explore strategies to continue the support.

### **The Evolution of forest education in Australia: from forestry to landscape and ecosystem management'**

Rodney Keenan

*Forest and Ecosystem Sciences, University of Melbourne, Australia*

Australia is the world's 6th-most forested nation, with 123 million ha of forests. Native forests have been actively managed by Traditional Owners for over 60,000 years. Removal of Indigenous management and loss of traditional forest knowledge following European invasion had profound impacts on forest landscapes. Significant forest areas have been cleared for agriculture and urban development. Timber production occurs in relatively small areas of native and plantation forests and most native forests are managed primarily for conservation, water, environmental services and fire protection. Farm trees and forests also provide significant benefits and services, both on-farm and to the broader community. This presentation reviews the evolution of professional forestry education

in Australia since establishment of the Victorian School of Forestry in 1910 and the Australian Forestry School in the newly created national capital of Canberra in 1926. The skill and knowledge requirements for forestry graduates has changed over time with changing forest management priorities, community attitudes and developments in scientific knowledge. Australian tertiary education has also undergone major change in recent decades, driving changes in programs and university departments to attract students and increase efficiency. In forest and land management programs an ecosystem, or landscape, perspective is now more prominent in university offerings. Many traditional forestry components are embedded in these broader aspects of ecosystem management while some elements are no longer taught. A large decline in research investment across the sector is also impacting on capacity to teach important subjects for forest industry. Forest and land management agencies are recruiting students from broader backgrounds with a combination of harder technical and analytical skills and soft skills in communication, public engagement and the sociology of decision making. Recent events, including bushfires of unprecedented scale in the summer of 2019-20, have stimulated calls for a new vision for forest management based in holistic thinking and world view of Traditional Owners Indigenous and giving them greater agency and developing the capacity of forests and people to adapt to a rapidly changing climate. This presents new challenges for the next generation of forest educators and students.

### Online Forestry Education in the New Era

[Youqing Luo](#)

[Yu Lin](#)

*Beijing Forestry University (Forestry Education Association), China*

It is a consensus for Chinese universities and institutions that information technology will bring revolutionary influences to modern education, and the deep integration with information technology will overwhelmingly transform the development of teaching and learning. China has now become a big country of MOOC, with over 5000 online courses and more than 70 million users.

This presentation analyzes the logics and hierarchical relations of key elements in modern educational information technologies, investigates the advantages and limits of MOOC which is not almighty in all circumstances, and illustrates the adaptation of MOOC in different course types. Meanwhile, we will share the latest progress of China's online forestry education in response to COVID-19 and solutions to online education in the new normal.

### Transforming Secondary Education In British Columbia

[Tyson Quan](#)

[Michael \(Tian Yi Li\), Jasper Liu](#)

*Canada*

British Columbia (B.C.) has rich and diverse natural resources including forests, agricultural land, fish, minerals, natural gas, and hydroelectricity. The mountains and long coastline of B.C. provide habitats for a variety of wildlife and many opportunities for outdoor recreation. The businesses and services from the sector of natural resources have contributed tremendously to B.C.'s economy and

employment. B.C. has well-established higher education systems such as universities, colleges, and institutes for preparing future workforce supply. However, there have been long-standing issues related to secondary education in the province, such as the lack of relevant curricular in natural science education and the absence of extra-curricular activities that can stimulate the interest of high schoolers. Due to the misleading and amplification of urban economic development in real estate and luxury businesses, students are more inclined to study business and finance. In the paper, the authors have explored the mismatch between high school education and university education, as well as the demand for the workforce from economic development in BC. The paper also projects the future development of BC's natural resources and renewal economy, and the requirement for talents of new generations. Suggestions and recommendations on how to streamline BC's secondary education to the future workplace have also been provided.

*Keywords: Natural Resources, Education, Career development, British Columbia*

### AP-FECM and its role in promoting forest research and education in Asia Pacific Region

Guangyu Wang

John Innes

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The Asia Pacific Forestry Education Coordination Mechanism (AP-FECM) was established in 2011 with 58 member universities across the region. The aim of the AP-FECM is to promote forest education and research cooperation through the platform with activities such as the development and delivery of online sustainable forest management courses, student mobility and faculty exchange programs, a young scientists' forum, summer programs and an annual symposium on forestry education. During the COVID-19 epidemic, APFECM provided 14 award-winning courses to Asia partner universities, benefiting more than 3500 students from 102 universities. In addition, the innovative online teaching model, which integrated a lead professor from the AP-FECM, local university teaching support, and learners' motivation, has dramatically enhanced both learning and teaching experiences, as well as their outcomes. This paper provides an overview of the programs and progress over the past 10 years, particularly during the COVID-19 epidemic. We also provide suggestions for future development.

*Keywords: Forest Education, Cooperation, COVID-19 response, and Asia Pacific Region*

### 2.3. Careers and Collaboration

#### A comparison of forestry continuing education academic degree programs

Wil de Jong

Yufang Zhuo, Kebiao Huang, Michael Kleine, Guangyu Wang

*Canada*

A well trained and skilled cadre of forestry professionals is one of the key requirements to make progress with multiple global efforts to assure a synergistic contribution of forests and the forest sector to sustainability goals. Societal demands on and expectations from forests and the forest sector have changed profoundly in recent times. Forests have been a key resource contributing to people's livelihood needs, but only since 30 years or so, has this been fully embraced among forest professionals as one of the responsibilities of the sector's role in society. Forests are the largest repository of carbon stocks and have only since the 2000s been assigned a major role in global efforts of climate change mitigation and adaptation. The changing role of the forest sector is resulting in changes in forestry higher education programs and curricula, but very unevenly in different regions of the world. One major effort to assure the required well trained and skilled forestry professionals who can implement technical management, public administration and knowledge creation are post graduate training and higher education programs for early career forestry professionals, referred to as continuing education. The programs aim to update professional's knowledge and skills to adjust to the changing societal demands on forests, but also to address deficiencies in professionals' higher education during their undergraduate education. The paper reviews and compares five programs that aim to update and improve knowledge and skills among forest professionals, with a special focus on the Asia Pacific region. After reviewing and comparing several programs, the paper reflects on trends and their possible implications.

#### Learning Forest Professionals: Meeting the Challenges of 21st Century Forest Management

Troy V. Lee

*Competence and Engagement, Association of BC Forest Professionals, Canada*

Today's forest professionals practice in a rapidly changing and often disruptive context. The pace of socio-ecological-political change can be bewildering. At the forefront is climate change. Drying landscapes, catastrophic fires, and unprecedented pest outbreaks are just a few of the challenges facing forest professionals practicing in British Columbia and around the world. Equally important is social change, as public values are also changing rapidly. As well, the Indigenous reconciliation mandate in UNDRIP and its adoption by British Columbia and other jurisdictions has laid bare the reality of our colonial past and set a trajectory towards reparations, land title, and collaborative forest management with First Nations. Additionally, the public and other forest users want to know what's going on in the woods, and provide input on how these diverse ecosystems are managed. Add to this legislative and regulatory changes, employer demands, and technological innovation, it begs the question: can forest professionals meet these challenges with foundational learning alone? Forest professionals, regulators, post-secondary institutions, and training providers can face these challenges by fostering a learning mindset; engaging in relevant, strategic, and accessible learning that uses the latest technologies; and by working collaboratively to develop and deliver curriculum

that equips forest professionals to meet real world problems. This multifaceted and collaborative approach to learning will equip forest professionals today to meet the challenges of tomorrow.

### What You Need to Embark on a Forestry Career in Canada

Casey Macaulay

*Canada*

Forest management presents a wide range of exciting and dynamic career options for those who want to pursue forestry work in Canada. A managed forest can be a large or small area with tree cover that is used for recreation, conservation or timber harvest – either in a remote area or within a city. Forest professionals are the people who ensure that forests are managed sustainably in a way that meets the objectives of the landowner. But what qualifies a person to be a competent forester? And who decides what skills and education are crucial for managing the forest ecosystem?

Canada is fortunate to have a national organization that coordinates the standards and required credentials for those who want to practice professional forestry. Eight provinces standardize the practice and are part of the Forest Professional Regulators of Canada (FPRC.) Together, these organizations regulate the work of thousands of professionals who manage forests across the country. The FPRC also oversees which university programs qualify for accreditation against the national standards for educating registered professional foresters (RPFs.)

For those who have other science-based degrees, there is still a route into the profession. The FPRC administers a national credential assessment program that evaluates a candidate's educational background and work experience against the national standards. Following that assessment, the candidate is given options for filling the gaps in their credentials. It is not an easy process but it does provide an alternate route to going back and re-qualifying at university for a forestry degree.

### The Greenest Workforce: An Information Hub for Job Seekers in Canada's Forest Sector

Ben McArthur

*FPAC, Canada*

Good pay and benefits, a wide range of career paths, opportunities to learn on the job – all this plus the pleasures of living in affordable communities with nature at your doorstep – Canada's forest sector is hiring!

Join Ben McArthur - Manager, Economics, Transportation, and Human Resources at Forest Products Association of Canada (FPAC) - as he walks through a unique resource for careers in forestry: The GreenestWorkforce.ca. The site provides a space where job seekers can find and apply for forest company job openings across the country, access information on the many advantages of living and working in forestry, and how to use the career path and job matching tools to help find your dream job.

If you are interested in a career in Canada's forest products industry, or if you're an industry employer with positions to fill, join the session for a discussion of how the Greenest Workforce can support you.

## Micro-Certificates in Continuing Education of Forestry Professionals

Jorma Neuvonen

Sheri-Andrews Key

*Faculty of Forestry, University of British Columbia, Canada*

Forest practitioners in Canada have a responsibility to the profession and the public to maintain their professional competence in their respective area of practice. Although maintaining this competence can be achieved in many ways, professional associations have often complained that there are not many university continuing education programs that are appropriate and feasible for working forestry professionals.

Micro-Certificate is a recognition of a specific skill set based on approved criteria for assessment with input from industry. It is a portable, consistent, clear communication tool that represents documented evidence of skills that can transfer across contexts and is implemented with sufficient credibility of official recognition and value. The digital representation of this achievement is a badge or digital badge.

The UBC Faculty of Forestry's Climate Vulnerability and Adaptation (CVA) Micro-Certificate is a flexible 10-week online program that provides forest professionals with an understanding of climate science, vulnerability assessments, adaptation development, and how it is applied to management and business case adaptation. It offers science-based, practical, hands-on training for professionals, including those currently working and those seeking to gain additional skills to better their employment opportunities. It provides a unique perspective that comes from collaboration and knowledge exchange between university researchers, government and industry partners.

## Forestry education and student competency

Mika Rekola

*University of Helsinki, Finland*

Competency means ability to perform or execute specific tasks in a given job-related context. In the rapidly changing world, technology is often the main driver of change in addition to political and economic turmoil. To renew the content of education especially curricula is a long-lasting process. Said that is understandable that only occasionally renewed curricula and rapidly changing competency needs are time-to-time conflicting in some extent. In many regions, forest education has typically been lacking so-called generic competencies and competencies related to social issues. Recent studies around tertiary forest education has shown some emerging topics such as competencies concerning time management, race/ethnicity and gender issues.

This presentation discusses transforming (tertiary) forest education for the future with two directions, collaboration and use of technology. Two innovations combining these directions are introduced, namely, Forest Education Global Core Curriculum (FEGCO) and Teachers' Forum. FEGCO could be given serious consideration as it provides an online platform for global discussion and a benchmark for practical development. Teachers' Forum could provide an online channel for communication around education innovations, peer-to-peer support/critics, and urgently called for teaching merits for academics.

## Helping Students Build Their Careers through Co-operative Education

Sanya Sivic, Nazlyn Pirani

*Faculty of Forestry, University of British Columbia*

Join us for this session to find out how the Faculty of Forestry students are prepared for their careers through the Co-operative Education program. The Faculty of Forestry Co-op Coordinators, Nazlyn Pirani and Sanya Sivic, will discuss what co-operative education is and how it has benefited their students, employers and faculty.

## ForYP: a Global Network for Forestry Young Professionals

Elaine Springgay

*Canada*

Who are the younger generations working in the forest sector? How does the sector invest in the professional development of its workforce to ensure it can adapt to new and future challenges?

Globally, the forest sector is evolving due to changes in societal values and the recognition that forests provide more than wood. The trend is seeing a decrease in traditional forestry jobs and an increase in other green forest jobs that often require new technological skills as well as a broader awareness of environmental and socio-economic issues. Meanwhile, the sector is facing an aging workforce, low recruitment, and an insufficient number of professionals with adequate technical and soft skills to meet new.

Educational programmes are adapting; however, the sector needs to invest in an enabling environment that allows young professionals to thrive and grow into the sector's experts and leaders, such as career development and technical skills training; knowledge-sharing, networking and mentorship opportunities; and acknowledging the skills, expertise and contributions of the sector's young professionals.

The Global Network for Forestry Young Professionals (ForYP) is a new network being established to connect young professionals in the forest sector around the world, address the needs of young professionals to succeed in their careers, and to improve continuity from student/entry-level to mid-career professional to senior expert. The new organization will launch at the World Forestry Congress in 2021 and is in the process of developing a strategy to ensure ForYP is an organization for and by young professionals that can partner with other organizations to strengthen the sector by actively engaging its different generations.

## 2.4. Forest Education Technology Development

### Untapped Resources: Increasing outdoor education by utilizing urban trees on a hyper-local scale

Kathleen Coupland

*Faculty of Forestry, University of British Columbia, Canada*

Forestry education has a long institutional legacy of including outdoor education as an integral pedagogical approach of disseminating forestry educational learning objectives (FELO). The dominant design of post-secondary outdoor forestry education (OFE) is through full or multi-day, intensive field schools that often run as independent courses and typically impose increased fees to students wishing to participate. These field school style opportunities are logistically, administratively, and financially challenging, requiring immense planning and dedication at all stages of development and implementation. While field school style experiences will always remain a critical part of a comprehensive forestry education, this research proposes that hyper-local urban forests can supplement these traditional approaches to OFE experiences. This supplementation can reduce the education burden placed on field schools and spread-out FELO, providing more time for comprehension and reflection. Urban forests (UF) and trees within short walkable distances of classrooms allow instructors to use real-world examples and demonstrations while constrained by lecture times that limit longer outdoor excursions to rural forests. By examining UF as if they were rural forests, it is possible to identify FELO that can be taught on these hyper-local scales. This case-study example at the University of British Columbia shows that high-resolution tree canopy cover analysis, where UF were classified based on rural forest canopy attributes, can connect FELO with different forest types and locations around the main teaching building. Analysing UF through a rural forest lens, expands the possibilities of teaching in outdoor locations. While it would always be ideal to get students into forests that closely match potential future working conditions, this is not always a reality. However, by viewing hyper-local UF as an opportunity rather than a constraint it become clear that UF could provide critical learning opportunities to all forestry students while simultaneously challenging the status quo of OFE.

### Virtual Field Instruction: Can it be done? Is it worth the effort?

Patrick Culbert

*Faculty of Forestry, University of British Columbia, Canada*

Learning in the field is a fundamental component of a sound forestry education. The pivot to online teaching during the COVID-19 pandemic forced all educators to dramatically change their practice, and field instruction was no exception. At UBC, FRST 350 - Foundational Field School is normally an 8-day intensive field course for incoming 3<sup>rd</sup>-year students transferring from our partner universities in China. The course introduces students to basic field skills as well as the ecology and management of forests in British Columbia. In August 2020, due to the pandemic, I taught the course online to students studying remotely in China. To quickly convert the course to an online format, I spent 9 days in the field filming HD video, 360° video, and 360° photography in an attempt to replicate the in-person course as closely as possible. Students expressed favorable opinions of the course, especially the HD and 360° videos. I will discuss the technical aspects and lessons learned from virtually

recreating a field course as well as my thoughts regarding how virtual field instruction might fit into forestry education in a post-COVID world.

### Improving your Remote Teaching with Lightboards

Michael Justason

*Faculty of Engineering, McMaster University, Canada*

This talk will introduce participants to lightboards, how they operate, as well as the requirements needed to set one up in a home or office to create an innovative virtual classroom. There will be examples of lightboard teaching techniques with a focus on improved student engagement. A structured presentation will be given followed by an open forum to allow for Q & A.

### Transforming Forestry Education through Technological Innovations

Juan M. Pulhin

Roberto B. Figueroa, Jr.

*College of Forestry and Natural Resources, University of the Philippines Los Banos, Philippines*

In the digital age characterized by the explosion of knowledge and information, effective utilization of technological innovations becomes paramount in the educational process due to its many advantages and potential positive outcomes. Like many other fields in the natural sciences, Forestry Education has been reaping the benefits of technological innovations as they are found to improve learning outcomes compared to the conventional approach. Effectively integrating these technologies has helped in creating new and updated curricula and materials, improving the efficiency of teaching and learning process, and making teaching more meaningful, collaborative, interactive, and responsive to the needs of the new generation of learners. Drawing from the experience of developing an online course in tropical sustainable forest management, this paper presents an innovative educational framework following the “Star Cycle Legacy model” that can guide the development and design of online courses as well as the teaching and learning process, thereby adding value to learning outcomes in modern day forestry education. The paper also briefly discusses the potential of modern technology like the use of 360-degree media to enhance the learning experience of the students. Some challenges and solutions in the use of new technologies in transforming forestry education will also be examined. This presentation hopes to provide a guide or scaffold that future online forestry course developers and educators could follow especially with the increasing need to provide online courses as tools for emergency remote teaching (ERT) amid the COVID-19 pandemic.

## Digital twin of the forest – how virtual reality can improve operational performance and land-based resource management

Dominik Roeser

Li Ji, Tim Caldecott

*Faculty of Forestry, University of British Columbia, Canada*

In order to advance decision making in operational planning, it is vital that forestry professionals are utilizing the most advanced tools and technologies. The lack of an intuitive and unified visual analytics platform prevents forestry stakeholders from fully exploiting the potential of data-driven decision-making, and is a barrier to effective multi-objective forest planning across large landscapes. Llamazoo, Interfor, the University of British Columbia Faculty of Forestry, and FPIInnovations have joined forces to address this challenge and have developed TimberOps, an immersive visual analytics platform to improve operational planning and decision making in forest resource planning.

To date, the ability to make optimal decisions is constrained primarily by access to timely, accurate, contextual information that is quickly accessible and easily understandable. The development of a digital twin of the forest represents a 21st century step towards aligning the varying interests for how forest landscapes are planned, utilized, and managed. TimberOps enables users to integrate diverse forestry datasets in a vast, virtual landscape, and delivers immersive analytics experiences through the state-of-the-art Virtual and Augmented Reality (VR/AR) Head-Mounted Displays (HMDs).

TimberOps is a photorealistic, high-fidelity data visualization platform that represents forestry datasets with detailed landscape and individual tree renderings, supporting the latest augmented and virtual reality (AR/VR) displays. It can be used to substitute a significant portion of expensive in-person field trips. It is designed to integrate all available datasets into one intuitive common operating picture, providing a centralized access point and a toolset with consistent interfaces for forestry analysts and stakeholders to examine and discuss forest management plans across various objectives.

Forest management today faces many diverse challenges and interests requiring a common operating picture for optimal management. Rapidly changing historical timber supplies – particularly in the context of unplanned natural disturbances of fire and/or disease outbreaks – brings home the necessity to evolve better closed-loop, supply-chain-centric decision-making tools. Forest resources in B.C. are largely tied to publicly-owned lands requiring public consultation and engagement. Additionally, competing interests for resource extraction, animal habitat, conservation, and recreation position the varying end-use objectives of forest resources squarely under the lens of rigorous scrutiny.

The TimberOps VR forest and lands planning tool can play a facilitation role, by providing an objective, visual, conversational tool – bridging the varying, though often complementary, forest management interests shared between stakeholders, the public and government policy. By providing a common operating picture that unifies all available data, visualization, and analytical tools in a VR-enabled virtual environment, TimberOps maximizes the use of available data to support collaborative decision-making. Furthermore, the tool aims at reducing costs and increasing productivity by minimizing reliance on field trips for forest management, as well as removing domain silos.

Projects to date include the development of a 500 ha proof of concept on Vancouver Island using Interfor's data. It was demonstrated in the fall of 2018, followed by a second phase of the project that focused on the full integration and compatibility of the tool with GIS and RoadEng. Subsequently, the Malcom Knapp Research Forest in Maple Ridge (5,000 ha) was also integrated in to the platform to test, scale-up, and to demonstrate TimberOps operational planning capabilities that can be used for teaching, demonstration, and research. Next steps include future developments focusing on the scalability of the tool, aimed at providing a fluid visualization and analytics experience for 300,000 hectares when the software tool reaches commercialization.

### Lessons learned in delivering the Innovative SFM Online Courses Amid the Pandemic

Anil Shrestha (1), Hailan Chen (2), Shiyi Zhang (3), Guangyu Wang (1)

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(3) APFNet, Beijing, China

AP-FECM Open Education Resources (OER) initiative with funding from APFNet have led the development and implementation of an internationally joint innovative sustainable forest management (SFM) OER program since 2013 based on need of such program in Asia-Pacific to address the challenges of changing context of global forest and forestry education. The program aims to improve access to sustainable forest management education, targeting the enhancement of teaching quality, curriculum, and research capacity for the universities in the Asia Pacific Region. Since 2016 the re-purposed OER courses have provided world-class forestry education resources to more than 15,000 learners from over 90 international economies. In this presentation, we will highlight how UBC Faculty of Forestry have led to develop a series of 14 state of the art SFM OER courses in partnership with Beijing Forestry University, University of Melbourne, University Putra Malaysia, University of the Philippines Los Baños, University of Florida and UBC Center for Teaching, Learning and Technology. We will also discuss the experience and lessons learned from the application of the existing OER courses across Asia-Pacific during the COVID pandemic. Further, implications to re-purpose the existing OER courses in the new normal will be discussed in the emerging new instructional models after COVID-19.

### Session 3. Communicating forestry to outside audiences

See also Keynote: [Exchanging knowledge: reflections on improving communication](#), presented by Chris Quine

#### Forestry communication in a virtual/hybrid world: transforming approaches to education and engagement

Neil Leveridge

Sarah Dickson-Hoyle

*Faculty of Forestry, University of British Columbia, Canada*

Forestry is increasingly promoted by international policy communities, governments and industries as playing a central role in addressing global challenges such as climate change mitigation, biodiversity conservation and sustainable development. In this context, foresters are often required to communicate with diverse audiences, from policymakers to the general public. However, forestry communication must extend beyond traditional ‘public education’ or the transmission of information from one individual or group to another. Strong communication skills are critical for meaningful community and stakeholder engagement, collaboration, knowledge mobilization and building social license to operate. Effective communication about forestry issues and practices also requires avoiding overly technical or discipline-specific jargon and being able to tailor messages to specific audiences. This is further challenged by the current Covid-19 pandemic, which has dramatically shifted our modes of communication. To prepare future forestry professionals with these necessary communications skills and adapt to the rapidly changing context of forestry and forestry communications, communications education within the UBC Faculty of Forestry has pivoted. In this presentation, we will share examples of how our teaching team transformed a more traditionally structured face-to-face graduate communications course to an adaptive online course, incorporating a range of technologies and online platforms that will assist students in this ongoing shift from face-to-face to virtual communications. Key components of this new course included more focused instruction on how audiences are influenced by different presentation modes; tools and technologies for recording presentations; and how to engage in audience discussion and critique online. Finally, we will identify priorities and strategies for continuing to enhance forestry communications education in today’s virtual/hybrid world.

#### Expanding the role of the International Society of Tropical Foresters in knowledge/tech transfer for tropical sustainability

W. Keith Moser

Sheila Ward

*International Society of Tropical Foresters, Arizona, USA*

The International Society of Tropical Foresters was founded in the middle of the 20<sup>th</sup> Century. Our organization was motivated “in response to a worldwide concern for the fate of tropical and subtropical forests.” ISTF is committed to the protection, wise management, and rational use of the world’s tropical forests. The ISTF mission is to “facilitate and promote sharing of best practices for

the effective management, protection, and equitable and ecologically sustainable use of tropical forests...” The transfer of data-information-knowledge (referred to here as “knowledge”) depends upon the users’ needs and capabilities and the characteristics of the D-I-K. Knowledge can inform more thoughtful understanding and management of our priceless natural resources and is even more important when those resources are endangered, as are tropical forests today. Thus, knowledge transfer is central to ISTF.

The capacity for moving knowledge between practitioners and researchers and policy makers can be limited for tropical countries. Barriers include limited budgets, researchers without time to engage in this work, lack of priority for moving knowledge, technological limitations, language barriers, the list goes on. Examples will be given of the consequences of gaps in knowledge transfer for tropical forests, and also of the successes that can result from timely sharing of information for managing tropical forests.

Knowledge transfer is not linear – the historical teacher-to-student model – but today looks more like a spider web, with landowners informing researchers who inform policymakers who inform consumers and all combinations in between. Given these many and varied sources of knowledge, ISTF does not seek to create new knowledge, but rather to make it available to those who can use it, and share the experiences of these knowledge consumers back with other elements of the knowledge web who might not otherwise be able to learn from these experiences. With its global membership network, ISTF can help bridge any gaps in the flow of knowledge. Our current tools include our website, physical and virtual outreach, publications, and various social media. We are in the process of organizing workshops and a mentoring program. We will present these and other options for knowledge transfer, and open up the session to hear additional ideas from the session participants.

### The Queen’s Commonwealth Canopy: promoting forests throughout the Commonwealth

[Alan Pottinger \(1\)](#)

[Nathan McKenzie \(2\)](#)

*Commonwealth Forestry Association, (1) United Kingdom, (2) Canada*

The Queen’s Commonwealth Canopy (QCC) is a unique network of forest conservation initiatives, which involves all 54 countries of the Commonwealth. It presents a rare opportunity to unite the whole Commonwealth family and save one of the world’s most important natural habitats – forests. By creating a pan-Commonwealth network of forest conservation projects, the QCC will mark Her Majesty The Queen’s service to the Commonwealth while conserving indigenous forests for future generations.

A major advantage of the QCC is its utilisation of existing forestry resources and projects throughout the Commonwealth. Participation is free and comes without regulatory obligations for accredited projects.

#### *Key Objectives*

The QCC is committed to raising awareness within the Commonwealth of the value of forests and to saving them for future generations.

It will create a unique network of forest conservation projects that brings collective credibility and integrity to individual Commonwealth initiatives.

It will raise the profile of the Commonwealth, demonstrating the capacity of its 54 member countries to act together as one to ensure forest conservation.

It will use the Commonwealth network to facilitate knowledge exchange, share best practice and create new, collaborative initiatives for forest conservation.

The QCC network has already created a physical and lasting legacy of The Queen's leadership of the Commonwealth.

Every Commonwealth country has the opportunity to participate in the QCC by nominating and dedicating existing or future conservation projects that meet the broad objectives of the initiative.

Those countries with limited forest cover will also have the opportunity to participate through the planting of native trees, the conservation of other indigenous vegetation, or by supporting QCC partnerships with fellow Commonwealth members.

So far, 49 countries are participating, with over 110 projects.

### Communicating science: A practical perspective

Terence Sunderland

*Faculty of Forestry, University of British Columbia, Canada*

Communicating science is now regarded as an important process to disseminate research findings, influence policy and have broader impact. Indeed, the donor and broader development community are beginning to place science communication at the centre of a broader outreach strategy that places a greater focus on knowledge sharing, transparency and accountability. The basic philosophy behind such initiatives is that public funding contributes to the generation of research findings and thus should be made available in forms accessible and understood by society more broadly. Not all researchers and academic see the importance of such a strategy and the majority of science writing, and thus knowledge, remains in scientific journals where knowledge is essentially “firewalled” through subscription. However, as societal expectations that knowledge generation be widened continue to change, a growing number of scientists are beginning to embrace new media that allow for broader communication of science and research. Through the use of traditional media such as radio and TV, contemporary social media, blogs, policy briefs etc. we, as scientists, can and arguably should, engage with a broader audience for wider societal change and impact. This presentation will focus on science communication strategies that have proven effective in “getting the message out” to a wider audience. Examples of bridging the research – policy divide, whereby science has actually informed legislation and practice, will also be shared.

## A Study of Maple Syrup Production in New Jersey

Judith Vogel

*University of Stockton, USA*

Maple sugaring represents an important sustainable use of forested lands, and promoting maple sugaring in New Jersey could lead to a better understanding of the role of agroforestry in sustainable land uses in this densely populated state. However, there are challenges associated with maple sugaring in New Jersey. While New Jersey has an abundance of red and silver maples, sugar maples are a less plentiful resource. In addition, factors in climate related to inadequate freeze/thaw contribute to a shorter and less productive sapping season. Finally, maple sugaring is historically not a part of the culture or economy of New Jersey.

This talk will present the methodology and outcomes of a significant USDA grant awarded to a team of faculty at Stockton University to study maple syrup production on Stockton's campus and in the South Jersey region. The grant uses a three-prong approach in its study: production, research and engagement. Using modern technologies (vacuum pump, RO, etc), an increased yield and efficiency displays evidence of sapping capabilities in a mid-Atlantic state and provides important information related to the potential impact of climate change on more northern states. Research efforts center on forest ecology and the impact of sapping on a virgin forest with a particular focus on soils. In addition, engagement efforts are promoting sustainable forestry practices to under-informed communities. These engagement initiatives bring together property owners of all types (backyards, farms, campgrounds, golf-courses, hunting land, etc.) with the goal of learning more about potential sapping in New Jersey. Finally, a significant aspect of this grant is building cooperative models in urban areas with a successful pilot program in Philadelphia proper. The blend of data-based, scientific research and community engagement makes this an important study for the future of sustainable land use in the mid-Atlantic region.

## Session 4. Climate Change

### 4.1. Climate change: Forest fires

See also Keynote: [\*\*\*Strategic Directions Towards Building Resilience to Wildland Fire in Canada\*\*\*](#)

Presented by Michael Norton

#### The challenges and role of fire in Australian forests under a changing climate

Tony Bartlett

Gary Morgan

##### *Australia*

Many Australian forest ecosystems are under significant threat as a result of an apparent increase in the frequency of intense forest fires under a changing climate, with the 2019-20 bushfire season seeing the largest area of forest burnt in south-eastern Australia since European settlement. While these recent bushfires have been subject to numerous inquiries, some of the most important underlying contributing factors and the associated responses required have not been given adequate consideration or have been dismissed. This presentation will examine both the challenges facing forest fire management in Australia and the key recommendations from bushfire inquiries over the past 20 years. It will summarize the issues that professional foresters consider have not been adequately addressed and present some 'step changes' that are necessary to address the increased risks to Australian communities and forest ecosystems from more frequent high-intensity forest fires. It will draw on the authors' experience in forest fire management and fire research, and present case studies of some of the large forest fires that have occurred in the past 20 years in southern-eastern Australia.

#### Addressing Anomalies in the Behaviour and Severity of Recent Large Fires in Central British Columbia

Phil Burton

Alana Clason, Sam Coggins, Kira Hoffman, Evelyn Hamilton

##### *University of Northern British Columbia, Canada*

Wildfires burned 2.5 million hectares in British Columbia (BC) in the summers of 2017 and 2018, largely in the plateau country of the Central Interior. Burning under high and extreme fire weather conditions, 20 large (each >10,000 ha) fires were examined to determine the vulnerability of different forest conditions to fire.

Burn severity mapping is conducted by the Province using the differenced normalized burn ratio (dNBR) index derived from satellite imagery captured before and after each fire. Maps are themed to portray areas burned severely, moderately, lightly, or left unburned, using identical thresholds to define those categories across all forest types. A retrospective analysis of mapped burn severity as related to pre-fire forest cover identified some anomalies. For example, many conifer plantations remained unburned while natural forest burned around them. Also, many broadleaf-leading stands

remained unburned or experienced reduced burn severity, as expected, but those in some fires apparently burned at greater severity than the surrounding forest.

Analysis of the silvicultural history of conifer plantations within subject fires revealed a significant relationship of their average burn severity to site preparation history and stand age. These results suggest that combination of microclimate, fuel loading, fuel arrangement, or fuel moisture conditions make many fully stocked juvenile stands more resistant to crown fire than previously thought. Composite Burn Inventory (CBI) field plots showed lower burn severities and more rapid forest recovery in aspen-leading stands than in conifer stands mapped at the same level of dNBR-based burn severity. Other effects of prior disturbance history, silvicultural treatments, stand composition, and surrounding forest attributes are still being assessed.

Our research suggests the need for a more refined characterization of fuels for the prediction of fire susceptibility in managed and unmanaged stands, and for the portrayal of wildfire impacts in central BC forests.

### **REFLOR-CV: Fires, desertification and communities**

Maria da Conceição Almeida Colaço

Francisco Rego, Luisa Morais

#### *Cape Verde*

The archipelago of Cape Verde with a semiarid climate is one of the most vulnerable states in the world to the impacts of climate change. Cyclic droughts, the increase of desertification and communities dependence of fuelwood has led the country to increase their afforestation efforts since the beginnings of the 80's from the XX century.

Within the framework of climate changes together with communities fire risk behaviors, small wildfires have started to occur in some of the islands, putting in dangerous the huge effort of afforestation to combat desertification.

To mitigate this problem, the project REFLOR-CV from FAO, Cape Verde Government and European Union, intends to create fire risk plans where the biophysical and social and economic dimensions are included. The methodology used by the project incorporates the needs, perceptions, practices and visions for the future held by the communities, together with the most updated wildfire risk analysis. This methodology consists on a triangulation of the social dimension, the current vegetation and present wildfire risk, and the historical data related to native vegetation.

The results from this work to increase communities preparedness and create a more safe landscape to wildfires (increase prevention and control of wildfires) will lead to a strong communities capacitation merging traditional and innovative knowledge, in order to change behaviors and increase forest co-management by the communities.

## Wildfires in British Columbia: Causes, Consequences and Coexistence

Lori Daniels

*Faculty of Forestry, University of British Columbia*

Wildfire is an essential process in forest ecosystems, but can be incredibly destructive in the wildland-urban interface. Wildfire is driven by climate, weather and fuels that vary among ecosystems and through time. Combined, land-use change, fire exclusion and global warming have made many forests highly susceptible to intense fires that are difficult to control and spread to large sizes. Revolutionizing forest and fire management will improve ecosystem resilience to climate change, but we will not stop future fires from burning. Successful adaptation must also include individuals and communities learning how to coexist with wildfire.

## Wildfires and Climate Change

Mike Flannigan

*Thompson Rivers University, Canada*

Wildfires are a frequent occurrence in many regions of the world. These fires are the result of interactions between climate/weather, fuels (vegetation – grass, leaves, needles, shrubs etc.), and people. Our climate and associated day-to-day weather are changing rapidly due to human activities that may have dramatic and unexpected impacts on regional and global fire activity. A warmer world means a longer fire season, more lightning activity, and most importantly drier fuels. Drier fuels means it is easier for a fire to start, to spread and it means more fuel is available to burn that leads to higher intensity fires that are difficult to impossible to extinguish. Existing studies suggest regional increases in fire occurrence and area burned although there is significant temporal and spatial variability. Climate change will likely mean more wildfire in the future for many regions of the world. We will have to learn to live with wildfire.

## Community Forest collaborations lead proactive wildfire management in British Columbia, Canada

Kelsey Copes-Gerbitz

Sarah Dickson-Hoyle, Shannon Hagerman, Lori Daniels

*Faculty of Forestry, University of British Columbia*

Worldwide, recent wildfire seasons have increasingly resulted in detrimental socio-economic and ecological impacts. In British Columbia (BC), Canada, the 2017 and 2018 wildfire seasons burned a record-breaking 2.5 million hectares and prompted widespread evacuations, highlighting the risk posed to communities that are embedded within forest ecosystems. While the COVID-19 pandemic has elevated the urgency of proactively addressing wildfire risk, many communities throughout BC remain unprepared and continue to face challenges in accessing the funding and expertise needed for effective wildfire management (including preparedness, prevention, response, and recovery). In this context, Community Forests - an area-based forest tenure license granted to local municipalities and First Nations communities - have emerged as leaders in facilitating collaborative approaches to address wildfire risk. Our research aimed to better understand these approaches, including factors that constrain and enable collaboration. Interviews with 24 community forest managers from diverse

communities and forest ecosystems highlighted factors such as provincial forest planning and legislative frameworks, and the diversity of values on the forested land base, that constrain their ability to undertake proactive wildfire management. At the same time, they identified enabling factors, including relationships, trust and community support, and funding and resource capacity as being key to successful collaborations for effective wildfire management. Community forests leverage these enabling factors to engage in a diversity of wildfire management approaches, from facilitating community planning and homeowner preparedness initiatives to implementing preventative fuels treatments and building capacity for wildfire response. Overarching priorities for the future of wildfire management in BC include: 1) refocusing broader forest management with a 'fire lens'; 2) managing (with) fire for landscape resilience; and 3) scaling up collaboration. To support these priorities, we highlight key recommendations to enable community forests in BC, and communities more broadly, to scale up collaborative and proactive approaches to wildfire management.

#### 4.2. Climate change: Carbon sequestration

See also Keynote: [Forests and Climate Change in India: Innovative Approaches for Carbon Sequestration](#), presented by Suresh Gairola

Nature Based Solutions: Carbon Sequestration by Trees in Urban Parks and Gardens of Katni City, Madhya Pradesh, India

Pratibha Bhatnagar

*India*

Tree in parks and gardens are considered as lungs of cities and are nature based solutions for providing a number of ecosystem services. A study was carried out in Katni city of Madhya Pradesh to estimate carbon sequestration by urban parks and gardens. Suitable trees for planting in parks and gardens were also identified based on a number of parameters like environmental, utility, hardiness. A non-destructive sampling approach was adopted to estimate sequestered carbon by using allometric equations as per IPCC GPG (2003). Species wise calculation was done of total carbon sequestered by trees of different species. There are 62 parks in Katni city, using systematic random sampling 26 parks comprising of small, medium and large parks covering 42% of the area were selected for study.

In the sampled parks a total of 340 tons of carbon were recorded and bringing it 100 per cent (all 62 parks) a total of 414 tons of carbon is sequestered by parks annually. The study observed that local effects like vegetation, nutrient status, texture, history of the site have an influence on carbon accumulation. The most common trees which were found in parks were Bottle palm (*Hyophorbe lagenicaulis*), Fishtailed palm (*Carota urens*) Ashok (*Polyalthia longifolia*), Neem (*Azadirachta indica*), Amaltas (*Cassia fistula*), Champa (*Magnolia champaca*), Saptarni (*Alstonia scholaris*), etc.

Twelve suitable species identified for parks are *Ficus benghalensis*, *Delonix regia*, *Millettia pinnata*, *Casia siamea*, *Ailanthus excelsa*, *Azadirachta indica*, *Ficus racemosa*, *Ficus religiosa*, *Peltophourm*

pterocarpus, Albizzia procera, Dalbergia sissoo and Albizzia lebbeck. In view of the contribution of trees to climate mitigation, planting of identified trees in urban areas of the state will go long way in improving environment.

### Assessment of Homegardens for Carbon Market in Sub Himalayan Region of West Bengal, India

Avinash Giri, Gopal and Sumit Chakravarty

*Department of Forestry, Uttar Banga Krishi Viswavidyalaya, West Bengal, India*

The carbon sequestration potential of homegardens are substantial but will be adequately recognized only when they are assessed for their ability to offset and generate carbon credits. The study was conducted from April, 2019 to March, 2020 at the forest villages of Buxa Tiger Reserve (BTR) in Terai zone of West Bengal, India. A total of ten villages and 100 homegardens were selected with multi-stage random sampling. Information on socio-economic profile of the respondents along with fodder and fuel wood utilization was obtained through a semi-structured questionnaire. Overall 63 woody species were documented including three palm and one bamboo species. The homegardens were very small with an average area of 0.0112 ha. Areca catechu a palm was prominently found in the homegardens due to its small canopy and commercial value. Overall average woody biomass, woody biomass carbon, SOC (up to 60 cm soil depth), ecosystem carbon, carbon offset and offset value for the sampled homegardens estimated was 4.83 Mg, 2.40 Mg, 0.74 Mg, 3.15 Mg, 11.52 Mg CO<sub>2</sub>e and 28.8 US \$, respectively, of which palms contributed 66.19 % of the total woody biomass. Multistep regression and canonical analysis revealed that the palms were responsible for more than three fourth of the homegarden biomass variability and thus also significantly influenced the carbon sequestered, offset and value of the offset. Significant positive relationships were also observed among the number of palms, palm biomass, total homegarden biomass and carbon, carbon offset and offset value. Larger homegardens and homegardens owned by higher household income were estimated with significantly higher carbon offset ability. Education level of the homegardens owners was not-significant in influencing the carbon offset. The homegardens in the studied villages also varied significantly in their ability to offset carbon but due to significant variation in number of trees. This indicates difference in cause of variability at landscape level i.e. at micro-landscape or homegarden level variation was due to palms, while at macro-landscape or village level trees caused variation. The study couldn't establish avoided deforestation as no households utilized fuel wood and fodder from their homegardens. The information generated is base line and can be vital for institutional intervention to initiate biocarbon projects in the region linking the poor communities with carbon trade. However, this needs empowering the livelihoods with capacity building and improved productivity particularly the palm Areca catechu which will attract these communities towards international carbon trade, while improving their resiliency and making them partners in global efforts of climate change mitigation.

*Keyword: Homegarden, Biomass, Carbon sequestration, Carbon credit, Climate change*

## EUROMOZ Forest recovery through emission capture

Arabelle Hurlstone

Ana Alonso

*United Kingdom and Mozambique*

Poster presentation

Euromoz Lda is a privately owned forestry management company headquartered in Beira City, Mozambique. It was founded in 1995 by Ana Alonso, a passionate conservationist. In 2004, Euromoz Lda was awarded a 50-year management contract of the largest concession within the province of Sofala comprising 600 km<sup>2</sup> of native forest.

The concession has one of the few remaining native forests within the Transvaal African Area. It contains precious wood tree species such as ebony, mahogany and the protected 'Music Tree' *Dalbergia Melanoxylon*.

With the emergence of Emission Reduction Projects as a tool to protect forests around the world, Euromoz commissioned a study by Garrigues Environment which found that the native species in the concession are estimated to produce @500 Emission Reduction Certificates (CERs). After Mozambique integrated REDD+ in 2018, Euromoz made an official request to pursue its EUROMOZ FOREST RECOVERY project. The final proposal will be presented in June. This would lead to Euromoz becoming the first independent and private entity to manage such a project. Ana Alonso is one of many who understand that native forests not only have an impact on our climate but can provide communities with financial independence from government and NGO-led assistance.

The project has three components:

- Territorial management of the forest delimiting the open areas of savanna and suitable land for cultivation.
- Continuous training of small agricultural entrepreneurs from the resident community so that it can move from subsistence agriculture to production agriculture. Promote a better standard of living through the attribution of farmland and the mechanized means of production.
- One year implementation phase only.

This model based on forestry and the agricultural training of communities relying on emission-reducing forests could form the basis for other such projects around the world.

## Sustainable management of timber bamboo plantations as a new promising "Climate Smart Forestry Strategy" – a case study from India

Lubina P.A

Syam Viswanath

*India*

3-Minute Talk

A Sustainable and cost-effective way of sustaining and enhancing bamboo productivity is by the application of biochar along with other organic amendments/inorganic fertilizers. Nothing goes wasted in the bamboo industry. Bamboo produces tons of litter per year which can be used for in situ composting. Culms or above-ground part after economic part extraction can be used to produce

bamboo biochar. These can be put back to the soil to sustain the productivity of bamboo plantations. The advantage of biochar is that it has got high surface area per volume which act as a substrate for microbes to multiply. This will improve the microclimate of the soil which in turn will increase the nutrient absorption plants. Studies show biochar applied soil has more potential to store more soil organic carbon. Improving soil organic carbon stocks improves the land quality. Biochar is a stable form of carbon and can last for thousands of years in the soil. In unmanaged bamboo clumps, carbon stock due to the production of new culms will be almost the same as that of carbon release due to decay and death of old culms. To avoid this, harvesting bamboo to make durable bamboo products is greatly beneficial. This will ensure carbon is locked and secured and thereby inhibiting its release back to the environment. A study was conducted in this regard in India on *Dendrocalamus stocksii*, a timber bamboo species that yielded promising results. So, sustainably managing timber bamboo species this way is a “climate-smart forestry strategy” because of its fast and renewable biomass production, improved livelihoods opportunity combined with mitigation and adaptation strategy to climate change.

### Biomass especially woody biomass: an essential ingredient to satisfy parts of the Paris Agreement on climate change

[Keith Openshaw](#)

USA

Poster presentation

All 197 countries of the world signed up to the Paris Agreement (P.A) on reducing greenhouse gas emissions and will submit their Nationally Determined Contributions (NDC's) at the 26<sup>th</sup> UNFCCC (Virtual) Conference of Parties (COP26) in Glasgow (Scotland) in late 2021.

Presently, only two countries will meet the goals of the P.A. because of the over-reliance on fossil fuels, excessive forest clearing, and agricultural/methane emissions.

The principal driver of deforestation is the increase in population, mainly in poor tropical countries, and to a lesser extent the expansion of commercial agriculture. If nothing is done to increase agricultural (and forestry) productivity and temper population increase, then deforestation will increase and so will GHGs. Tempering population increase and improved agricultural efficiency is therefore essential to meet the global warming target of the Paris Agreement by 2100. With more effective family planning programs and improved efficiency, 167 million ha of forests, containing 17GtC, (62GtCO<sub>2</sub>) valued at an estimated \$42.5 billion could be saved from conversion to subsistence agriculture. Improving agricultural productivity, especially in the subsistence sector, would avoid additional significant forest loss.

Consecutively, fossil fuel consumption can partly be reduced through efficiency measures, and especially by greatly expanding the use of renewable energy. While renewable energy from water, wind and solar have a major role to play, biomass is currently the most important renewable fuel. Expanding its use requires improvements in intermediate and end-use efficiency. Increased use of biomass energy from sustainably managed sources could facilitate more investment in forests and increase the capture of carbon – a necessity to meet the goals of the P.A. A program to plant trees on the equivalent of 0.9 billion ha of land could capture about 409GtC (1,500GtCO<sub>2</sub>) in wood and soils

and cost an estimated \$2,000 to 2,500 billion (\$10<sup>9</sup>). In addition, an estimated \$500 billion would be required for population reduction measures, increasing agricultural productivity and improving the social infrastructure etc

These measures would greatly assist in keeping the global temperature increase to 1.5°C above the pre-industrial level, ensuring that the world remains habitable and environmentally sustainable.

*Key words. Paris Agreement; deforestation, reforestation, carbon capture and storage, renewable energy expansion, tempering population increase; improving agricultural productivity.*

### Soil Organic Carbon stocks (SOC) and sequestration potential of Permanent Preservation Plots (PPP's) in wet evergreen and moist deciduous forests in Central Western Ghats of Karnataka, their sustainability and land use types

Pavithra G.M.

Anil Kumar, Syam Viswanath, Namasivayam Ravi, Karthika K. S., Sruthi Subbanna, Lubina P.A

*India*

Poster Presentation

A study was undertaken to characterize, classify and evaluate soil organic carbon stocks and sequestration potential of Permanent Preservation Plots (PPPs) in wet evergreen and moist deciduous forest types and a comparison was made in adjoining agricultural and degraded land use types. Elevation of the study areas Katelekan, Malemane, Karka, Bhagavati and Kulagi was 914, 903, 552, 505.9 and 438 m above MSL respectively. Climatic analysis of the study area revealed that the annual rainfall (mm) varied from 1500 mm to 4500mm and was more at steep and gradual terrain landforms. The site description of soil morphological observations was recorded during soil profile study up to one-meter depth, to understand the changes in soil development with emphasis on soil organic carbon (SOC) stocks. Basic Physico-chemical analyses of soil samples to estimate bulk density, porosity, particle size analysis, and moisture content were carried out. The wet evergreen forests in Katelekan and Malemane recorded high organic carbon percent in the surface (1.42-3.11 %) due to enough above-ground biomass accumulation as a result of better canopy cover in these forests .and hence very high carbon sequestration potential (22.42- 40.84 kg m<sup>-3</sup>). Agricultural lands and degraded lands recorded very high carbon sequestration potential of 15.71-30.88 kgm<sup>-3</sup> and 14.64-35.74 kgm<sup>-3</sup> respectively at the surface. However, the moist deciduous forests of Bhagavati, Kulagi, and Karka recorded medium to high organic carbon percent (0.62-2.87 %) on surface soil and high to very high carbon sequestration potential (13.22-27.28 kg m<sup>-3</sup>) as these have only average aboveground biomass accumulation through litter due to medium forest canopy cover under teak plantation. Agricultural lands recorded moderate to very high carbon sequestration potential (11.40-28.57 kg m<sup>-3</sup>) and degraded lands recorded medium to very high carbon sequestration potential (8.07-34.40 kg m<sup>-3</sup>) on the surface soils of Bhagavati, Kulagi and Karka.

## How can we sequester more carbon in forest soils?

Cindy Prescott

*Faculty of Forestry, University of British Columbia, Canada*

Forest soils hold about half of the total organic C in terrestrial ecosystems globally and have the potential to sequester more carbon. Opportunities to increase stocks of soil C have been improved by recent developments in our understanding of soil organic matter formation. It is now clear that microbial transformation of organic matter is critical to generating more stable soil organic matter. In turn, the key to generating the necessary microbial biomass, necromass and transformation products is the production and release of labile forms of C and N from plant roots and root associates such as mycorrhizal fungi. This paradigm shift in our understanding of soil organic matter formation has implications for managing forests to generate stable soil organic matter to offset land degradation and sequester more C in forest soils. This entails a shift in focus away from dead and recalcitrant materials to labile sources of energy and nutrients that support the living soil ecosystem. I will explain the new view of soil organic matter generation, and the implications for how we could manage forests differently to regenerate soil organic matter stocks, restore degraded soils, and sequester more C in forest soils.

## Biomass estimation in mangrove forest: a comparison of allometric models incorporating species and structural information

Md Saidur Rahman

Daniel N. M. Donoghue, Louise J. Bracken, Hossain Mahmood

*United Kingdom*

The accuracy of biomass estimation in tropical forests is debated at all scales due to errors caused by failing to address individual tree identity in the allometric models. The unavailability of species-specific allometric models limits our understanding of how individual tree species contribute to the carbon stock within ecosystems. To understand how individual species affect biomass on individual and plot level, nine species-specific allometric models were developed from empirical data gathered by semi-destructively sampling 326 trees from the Sundarbans mangrove forest, Bangladesh. Data were used to compare the aboveground biomass (AGB) between the species-specific model and seven frequently used pan-tropical and Sundarbans-specific generic model. The effect of individual tree species was also evaluated with various model parameters for wood densities (from individual trees to the whole Sundarbans) and tree heights (individual, plot average and plot top height). All nine species-specific models explained a high percentage of the variance in tree AGB ( $R^2 = 0.97$  to  $0.99$ ) with the diameter at breast height (DBH) and total height (H). At the individual tree level, the generic allometric models overestimated AGB from 22% to 167% compared to the species-specific models. The plot-level mean AGB varied from 111.36 Mg ha<sup>-1</sup> to 299.48 Mg ha<sup>-1</sup>, where AGB significantly differed in all generic and species-specific models ( $p < 0.05$ ). Measured species WD showed significantly 4.5% to 9.7% less biomass than WD from the database and averaged WD in the plot, salinity zone and the whole Sundarbans scale ( $p < 0.05$ ). Instead of using individual tree height, the AGB was significantly overestimated by 19.5 % and 8.3% when using plot top height and plot average height, respectively ( $p < 0.05$ ). Tree level measurement from the inventory should therefore

be included in all allometric models to obtain an accurate estimation of forest carbon in tropical forests.

### Contribution of planted forests to climate change mitigation and adaptation

Seongmin Shin

Himlal Baral

*Canada*

Numerous tree planting initiatives have emerged in recent years promoting tree planting as a silver bullet for climate change and other socio-economic and environmental problems. In many cases, however, planted forests have more complex and uncertain climate impacts than we generally acknowledge. Therefore, this research aims to examine and synthesize evidence relating to planted forests and their role in climate change mitigation and adaptation. We found in many cases that planted forests have a huge role to play in climate change adaptation and mitigation as the most effective strategy for carbon sequestration through photosynthetic carbon capture, soil organic carbon, and biomass. We also found several unintended side effects of planted forests, such as a net warming effect at high latitudes, marginal carbon benefits, NO<sub>2</sub> emissions, and risks of forests fires. Additionally, climate change may have significant impacts on planted forests with changing rainfall patterns and droughts. This research explores appropriate tree species, places, and purposes as balanced solutions for increasing the success of tree planting efforts in mitigating climate change. It navigates and suggests balanced principles and solutions for policymakers, tree planners, implementors and local stakeholders to minimize trade-offs and risks when planting trees.

### Biomass and Carbon Storage in Gmelina arborea Plantation at Agricultural Landscape in Foothills of Eastern Himalayas

Gopal Shukla

Mendup Tamang, Sumit Chakravarty

*Department of Forestry, Uttar Banga Krishi Viswavidyalaya, West Bengal, India*

Poster presentation

In the modern era, potential of Gmelina arborea plantations is the hot spot of research because of the great potential of carbon sequestration and further help in carbon deduction strategies. The present work was conducted from September 2018 to February 2020 in randomly selected Gmelina farm forestry under young unmanaged plantations. The study area was categorized into three age classes, i.e., ≤ 5, 5-10, and 10-15 years. In a plantation, Gmelina trees (10%) were randomly selected while other trees (90%) were also taken into the consideration. A stratified random nested quadrat sampling method was adopted for analysing other vegetation forms within a plantation. We found 51 individual species in the studied Gmelina farm forestry plantations; including 23 tree species, seven shrub species, 16 herbs, two climbers and three species of ferns. Four species were not identified. The estimated quantitative vegetation parameters and diversity indices indicate that the plant assemblages were heterogeneous with native diverse species evenly distributed with fairly higher density, frequency, and abundance. Herbs were the most important species followed by

shrubs and trees. With the increasing age of plantation, the richness of plant species increased. Soil properties were significantly influenced by the age of the plantation but exhibited no discrete trend with increasing plantation age. Total biomass density and total carbon density increased with increasing plantation age while no drastic variation was found in available soil organic carbon (SOC) as litter production also not shown any significant variation. Total plant carbon, total available SOC (up to 60 cm depth) and ecosystem carbon in the three age class plantations were 54.51-59.91, 48.18-55.73 and 104.81-110.77 Mg ha<sup>-1</sup>, respectively. The potential of carbon sink in these studied Gmelina plantations was found to be less than the forests but having enough potential to convert unutilized agricultural landscape and could generate carbon credits.

*Keywords: Plantation; Climate change; Land use management; Carbon sequestration; Soil*

**The soil quality of the world's largest refugee campsites located in the Hill forest of Bangladesh and the way forward to improve the soil quality**

Md. Seikh Sadiul Islam Tanvir

*Bangladesh*

Poster Presentation

More than 1 Million Rohingya refugees entered Bangladesh until 2020. The refugee camps have been established in the forest areas of Cox's Bazar. The total area of the camps coverage more than 1800 ha of natural hill forest. The camps' establishment caused detrimental effects to the forest landscape by cutting and leveling hills and removing trees which made the land unproductive for any vegetation growth.

The objectives of the study were to develop a database on the soil quality of the sites and to prescribe native species for future plantation.

A total of 102 sample collection points from 20 camps were taken. The campsites were divided into 4 categories according to their different land-use types such as denuded hillsides, block plantation without terrace, plantation on the earthen terrace, and plantation on the bamboo terrace.

Different soil parameter of the samples like EC, pH, Nitrogen, Phosphorus, Potassium, and organic carbon were assessed.

Comparatively higher stocks of nutrients were observed for block plantation without terrace as it has some existing vegetation, while lowest stocks were observed for control- denuded sites as it was totally barren.

A soil fertility index was made which is quite common for agricultural soil but a new initiative for the forest soil of Bangladesh. The campsites were found medium and low fertile.

A list of 40 potential native tree species was recommended for restoration of the sites. As native species are environmentally more viable for restoration of degraded land.

The species were categorized according to their suitable site condition. Such as heavily degraded sites with full sunlight, Sandy textured soil with full sunlight.

It can be concluded that plantation of site-specific tree species, their maintenance and protection may enhance the tree cover in the campsites, which can improve the nutrient stock, physio-chemical properties and biodiversity of the soil.

#### 4.3. Climate change: Insect Outbreaks

**An account of genus *Oligosita* & *Pseudoligosita* (Chalcidoidea: Trichogrammatidae) Egg Parasitoids from Jammu & Kashmir (India)**

Yawar Manzoor Bhat

Mohd. Yousuf

*Forest Protection Division Forest Research Institute, India*

Poster Presentation

Trichogrammatidae (Hymenoptera: Chalcidoidea) is an important and least-studied family in Chalcidoidea, mainly due to their small size, ranging in size from 0.2-1.5mm and easily characterized by having 3-segmented tarsi. The family Trichogrammatidae constitutes of economically and ecologically important group of insect egg parasitoids of various forest and agriculture insect pests mostly belonging to the orders Lepidoptera, Hemiptera, and a few of Coleoptera, Diptera and Thysanoptera. Trichogrammatids are universally accepted egg parasitoids for biological control of large number of Lepidopterous insect pests of agricultural and horticultural crops as well as insect pests of valuable forestry tree species. Species of Genus *Trichogramma* have achieved very high position in applied biological control of insect pests, as several species of *Trichogramma* are being multiplied in laboratories and these are being released in fields for biological control of insect pests. The family Trichogrammatidae is represented by 96 genera and more than 1000 species distributed throughout the world, out of which 31 genera and 175 species are known from India, and just 6 species belonging to 2 genera have been recorded from Jammu & Kashmir prior to the current study. During the present survey, several trichogrammatids have been collected from Forestry and Agro forestry areas of Jammu & Kashmir (India). Screening of species of two diverse genera *Oligosita* and *Pseudoligosita* was carried out for the first time from Jammu & Kashmir. Ten species of the two genera: *Oligosita sanguinea*, *Oligosita ferozepurensis*, *Oligosita meerutensis*, *Oligosita longirhinaria*, *Oligosita breviclavata*, *Pseudoligosita nephotetticum*, *Pseudoligosita yasumatsui*, *Pseudoligosita ernakulamensis*,

*Pseudoligosita latipennis*, *Pseudoligosita longicilia* have been recorded for the first time from Jammu & Kashmir. These trichogrammatids can be utilized in biological control of various forest and agriculture insect pests, after testing their laboratory efficacy and standardization of their mass multiplication techniques.

**Key words:** *Biological control, Egg Parasitoids, Hymenoptera, Jammu & Kashmir, Trichogrammatidae.*

**Bio-ecology of longhorn beetle, *Xylotrechus basifuliginosus* (Heller,1926) (Coleoptera: Cerambycidae), a borer of Kharsu oak (*Quercus semecarpifolia* Smith) trees in Western Himalayan temperate forests in India**

Gaurav Chand Ramola

Arun Pratap Singh

*India*

Poster Presentation

*Xylotrechus basifuliginosus* is a secondary stem borer of kharsu oak *Quercus semecarpifolia* (Family: Fagaceae) in high altitude temperate forests in the Uttarakhand state lying in the Western Himalayas. Life-history was found to be annual with 5 larval instars. Emergence of beetles on standing dead and dying oak trees occurred at the onset of the rainy season during June-July. Females soon after the copulation lay up to 50 eggs in cervices and covered depressions on the bark surface on those trees initially infested by primary borer *Rosalia lateritia* Hope. The neonate larvae on hatching start feeding on the bark and there after enter the bast and sap wood in summer. The larval galleries are irregular up to 50 cm in length. Larval feeding causes wilting, drying up of leaves and ejection of large quantity of frass on the ground of standing trees. Larvae continue feeding in the sapwood and then go into hibernation in winter (November-March) in a pupal chamber excavated parallel to the longitudinal axis of the tree. Pupation is triggered by sudden rise in temperature in spring (March). Pupal period is 2-3 months and beetles emerge by escaping the pupal chamber by chewing the bark and making a circular exit-hole in summer. An exit hole in the wood is an indicator of the completion of life cycle. A positive relationship was established between the degree of past disturbance (mainly lopping of oak trees for fuelwood and fodder for livestock) with the number of infested trees. Under outbreak conditions, every tree in the stand might be attacked. Kharsu oak is an important climax species in the high altitude western Himalayan forests, and this borer along with *R. lateritia* is one of the major factor in its decline in the western Himalayan region recently besides reducing the quality of its timber.

#### 4.4. Climate change: Seed transfer

See also Keynote: [\*Assisted migration and the reluctant acceptance of new forest interventions as a climate adaptation strategy\*](#), presented by Shannon Hagerman.

Co-authors: Robert Kozak, Guillaume Peterson St-Laurent, Ricardo Pelai, Ngaiio Hotte, Veronika Gukova, Noa Mayer, Kieran Findlater

**Time to get moving: Phenotypic and genomic approaches informing assisted migration in reforestation**

Sally N. Aitken

Rafael C. Ribeiro, Brandon M. Lind, Dragana Obrecht Vidacovich, Beth Roskilly, Judith Nuhu

*Faculty of Forestry, University of British Columbia, Canada*

Climate change is disrupting the match between local tree populations and the climates they inhabit. Increasing levels of maladaptation are predicted for local populations of trees this century. Assisted migration within species ranges is one tool for reducing the impacts of climate change on planted forests, but changes in seed source from local to non-local need to be informed by genetic data. Large-scale field provenance trials can provide excellent data for characterizing local adaptation to climate, but they are time consuming and expensive to establish, and comprehensive trials are lacking for many species. In the AdapTree and CoAdapTree projects, we have combined short-term seedling common garden experiments in controlled environments and genomic data to understand local adaptation to climate, to identify key climatic drivers and traits involved in local adaptation, and to predict the extent of maladaptation under projected future climates for conifer populations in Western Canada. For both lodgepole pine (*Pinus contorta*) and Douglas-fir (*Pseudotsuga menziesii*), both phenotypic and genomic data indicate local adaptation is driven primarily by temperature, and secondarily by summer moisture and aridity. Populations differ strongly for bud set phenology and cold hardiness, but not for drought hardiness. Genotype environment association approaches can successfully identify key climatic factors, while genome wide association approaches can identify the genetic basis of climate adaptation for traits including drought hardiness, cold tolerance, and disease tolerance. Collectively, these studies can guide assisted migration within species ranges by matching seed sources with new climates. Reforestation strategies should also consider uncertainties around climate projections and extreme weather events, and maintain high levels of genetic diversity in reforestation and restoration planting stock to buffer this uncertainty.

## Impact of climate change in Western Himalayas: A review study

Krishna Kumari

R. K. Verma

*Himalayan Forest Research Institute, India*

Poster Presentation

Himalayas is one of the biological hot spot of the world and conserving the nature in its vicinity. It is the home for many plants and animals which will lose their existence, if it will not be conserved. Himalayan ecosystems are projected to be extremely sensitive under future climate. As a part of the Himalayan mountain ecosystem, Western Himalayan hosts a wide range of biological diversity and natural resources. The Himalayas has unique forests and diverse habitats with large altitudinal variations. Any change in temperature or rainfall pattern will adversely impact the entire ecosystem. Further, Himalayan ecosystems are highly vulnerable due to the stress caused by forest land diversion, increasing pressure from human population, exploitation of natural resources, habitat destruction, infrastructure development, mining, deforestation and other related challenges. In recent years there is change in the climate like rainfall pattern divergent, snowfall variation, shift in the seasons which affects our nature directly and indirectly but adversely. The effect of these current stressors is likely to be exacerbated due to climatic changes, which would be additional Climate change impact and vulnerability assessment at regional levels is necessary to develop adaptation strategies for forests in the biogeographically vital Himalayan region. This review study assesses forest ecosystem vulnerability to climate change and how climate change is affecting the Western Himalayas. This study will help for adaptation planning for combating climate change impacts. Identifying vulnerable forest ecosystems and will help policy makers and forest managers to prioritize resource allocation and forest management interventions, to restore health and productivity of forests and to build long-term resilience to climate change.

## Using Ecological Niche Modelling to determine the ecological requirements and geographical occurrence of *Phragmanthera* spp. a woody parasitic plant in Rift Valley ecoregion of Kenya

Angela Muthama

Jesse Owino

*Kenya*

3-Minute Talk

Genus *Phragmanthera* (Loranthaceae) family is in one of the families of mistletoes which are parasitic plants that solely depend on their hosts for nutrients and water once attached. The parasitism leads to wilting and drying up of the infested part in cases of high infestation mortality of the tree affected. Members of the genus were observed to parasitize tree hosts in the Rift Valley ecoregion through a transect survey. The locations of the parasitic plant were recorded and used for Maximum Entropy (Maxent) modelling to determine environmental conditions making up the niche of the parasite and to develop suitability maps of the parasitic plant within Rift Valley ecoregion. 27 occurrence records representing 102 trees were correlated to the 19 Bioclimatic variables representing temperature and precipitation conditions globally. The species identified in this study is *Phragmanthera cornetti* with key host species being *Cupressus sempervirens* var. *pyramidalis*, *Schinus molle* and *Jacaranda*

mimisifolia which are ornamental trees. Maximum Entropy software (Maxent) version 3.4 was used to determine the species suitability of *Phragmanthera cornetti* identifying Baringo, Nakuru, Uasin Gishu, Transzoia and Elgeyo Marakwet Counties as hot spots for infestation by the parasitic plant. Environmental variables weighed as most critical to *Phragmanthera cornetti* distribution in the sampled area were precipitation of coldest quarter, precipitation of driest month, Temperature seasonality, Isothermality and minimum temperature of coldest month. These variables were ranked using their individual contribution to the model (AUC=0.935) computed on MaxEnt correlating the occurrences to Bioclimatic variables. The identified counties within the predicted ranges of *Phragmanthera cornetti* infestation should begin using more resistant or less susceptible tree species for their tree growing programs. Pruning of infested branches can be used to reduce spread of the parasite. Further studies into more effective control measures for the parasitic plants are being investigated for a more integrated approach.

#### 4.5. Climate change: Communities

##### **Solar energy technology: resorting to renewable energy for socioeconomic and ecological development of wood industries in Nigeria**

Oladele Amoo-Onidundu

*Forestry Research Institute, Nigeria*

Poster Presentation

Energy is one of the most important indices which influences socioeconomic and ecological development of a nation. Nigeria has inestimable potentials of harnessing several energy sources but hydroelectricity (renewable energy) and fossil fuels (non-renewable energy) seem to be major sources of power which are given paramount attention. Consequently, little is done to finding alternatives to aforementioned energy sources. Up till date, Nigeria has not met the ever-increasing need for power supply in domestic and industrial purposes. Fuel price hike, gas flaring, epileptic power supply, land and air pollution, global warming and climate change are among the threats associated with the present energy nexus in Nigeria. Unfortunately, these have bedevilled Nigeria's socioeconomic and ecological development causing untold hardship on human existence. The wood processing industry is among the major sectors which immensely contribute to socioeconomic and ecological development of Nigeria. The industry is energy intensive with power taking about 75-85% of the production processes. Due to Shortage in power supply, wood industries in Nigeria are gradually declining in performance, efficiency and productivity. This has resulted into high cost of wood based products, infiltration of timber markets with substandard products, severe pollution, close-down of sawmills and wood-based firms, undue importation of wood products, loss of jobs, economic imbalance, downtime, just to mention a few. Considering its numerous potentials, solar energy technology has ability to combat the energy menace and contribute to sustainable socioeconomic and environmental development in the Nigeria wood drying industry.

*Keywords: Renewable energy, wood processing, Nigeria, socioeconomic and ecological.*

## Community Empowerment for increasing adaptation and resilience to climate change in Cabo Verde

José Lopes

*Cape Verde*

“Adaptation”, “resiliency” and “sustainability” are popular catchwords in today’s mainstream development policies, as national and international organizations seek to address climate change impacts across the world. Governments and international development agencies around the globe strive to design and implement innovative policy tools to increase countries’ adaptive capacity and resilience to climate change, and therefore, achieve “sustainable” development goals. The achievement of these goals, nevertheless, is even more challenging for Small-Island Developing States, in which Cabo Verde is part of, as their vulnerability and shortage of resources may impair their efforts. To overcome such a challenge, empowerment of local stakeholders through capacity development initiatives stands as a key strategy. It is against this backdrop that this article is framed. By studying the Cabo Verdean policies to climate change, the article analyzes the country’s experience in engaging rural communities through capacity building and development initiatives to increase their adaptive capacity and resilience. This analysis is essentially qualitative, and bases on an extensive desk research and review of the country’s major environmental and development policies and projects implemented in the last decade. A field study will also be carried out, through in-depth interviews and observations, to grasp from within the local communities’ adaptive and resilience experiences.

*Key words: climate change, adaptation, resilience, sustainability, local communities, empowerment*

## Tree rings say where to plant cacao trees in Ivory Coast (West Africa)

Alice Gargano

Paolo Cherubini, Laurens Michiels van Kessenich, Agathe Dié, Holger Gärtner, Matthias Saurer, Loic Schneider, Lukas Wacker

*Swiss Federal Institute for Forest, Snow and Landscape Research, Switzerland*

Cocoa is one of the most important source of income in many tropical and subtropical countries. Ivory Coast provides approximately 40% of the world supply of commercial cocoa. Cocoa farming, production and export, in Ivory Coast, plays a crucial vital role for the survival of local populations, and the economy. Cocoa production is threatened by climatic changes, mainly by an increase in drought frequency and severity. Tree rings can be used to understand cacao tree reaction to past droughts. Mapping such information will help to predict areas most likely prone to risks for cacao tree plantations, and thus help land management for cocoa farming. Tree cores and stem disks were sampled at different sites in the "cocoa belt" in southern Ivory Coast. Several different techniques were applied to identify the tree-ring growth zones and understand if they are formed annually or not. Dendrochronological and wood anatomical methods, a permutation script correlating ring-width measurements with precipitation data, and wood stable isotopes ( $^{13}\text{C}$  and  $^{18}\text{O}$ ) and radiocarbon ( $^{14}\text{C}$ ) analyses showed that cacao trees do not form always one ring every year, but often two or more. These intra-annual density fluctuations probably reflect changes between wet and dry seasons. According to the permutation-correlation analyses, tree rings at the driest sites seem to correlate with precipitation. Spatial differences in the distinctness of tree-ring borders were identified: the

areas where trees have clearer rings are mainly at the northernmost sites, where trees are strongly affected by drought, and therefore stop their growth during the dry season. Thus, wood anatomy in combination with statistical analysis, stable isotopes and radiocarbon analyses helped to identify the regions where drought had the most severe impact. Tree rings help identify the regions where cacao trees plantations are more prone to suffer if drought severity and frequency will increase.

### Community perceptions on changing climatic variables and their impact on Non-timber forest products

Muneer Magry

David Cahill, James Rookes, Sapna Narula

#### *India*

Climate change impacts are disseminated disproportionately across the societies, the marginalized, the poor have been majorly affected and amongst these forest-based communities have been impacted severely. As we move into action taken a decade of sustainable development goals, it becomes imperative to empower and safeguard the livelihoods of forest-dependent communities considering their role in achieving the global goals. The study deals with the investigation of changing trends in climatic variabilities and their impact on Non-timber forest products (NTFPs) in the Jharkhand state of India where NTFPs play a significant role in providing livelihoods to the forest-dependent communities. Participatory methods were used for primary data collection that included structured questionnaire survey, focused group discussions, and transect walk. The climate trend analysis was carried out using the Man-Kendall test and Sens's slope estimation, the results revealed that there has been an increase in temperature and decline in rainfall over the years (1980-2018). As the respondents have been living in the study region for decades and observing the climate changes, they agreed with trend analysis results and highlighted infrastructure development as one of the major reasons for this change. A case study result revealed that temperature has been impacting the lac yield (*kerria lacca*) over the years (1980-2018), a unit increase in mean temperature has led to a decrease in lac yield approx. 8.58 tones/year. Further, the challenges faced by the NTFP collectors in terms of climatic adaptation and coping strategies were analyzed and it was found that climate change coping strategies are poorly developed, based on the results some novel interventions have been suggested for adaptation practices to cope with climate change. This study provides evidence of climate change impacts on NTFPs and recommends for possible, timely taken actions by concerned stakeholders.

## An evaluation of a gender integration workshop in Irangi Forest, Kenya

Elizabeth Racine

Teresa Gitonga, Kate Schreckenberg, Ricardo Romero

*Kenya*

### Poster Presentation

There is a growing consensus and evidence that integrating gender is critical for the success of managing natural resources, improving livelihoods, and initiatives to combat climate change. At the same time, an extensive body of literature documents gender disparities in rural communities and the systematic exclusion of women in decision-making spaces and leadership roles. Studies have shown that women tend to improve natural resource management decisions because they play a direct role in conservation practices. In this study we explored how gender impacts forest management practices and how to strengthen community-level tree-growing initiatives by better understanding of gender issues. We analyzed data produced by a 'gender integration' workshop with participants involved in management of the Irangi Forest, Kenya to describe the challenges women face in natural resource management. The 17 men and 13 women took part in various activities discussing the difference between gender and sex and gender as a social construct, and how these views influence leadership decision-making roles in natural resource management. The participants also compared the division of labour between men and women and discussed the impacts of overburdening women in the community. We found that in the Irangi Forest women have fewer land ownership rights than men, and any rights often depend on male oversight, negatively impacting their leadership capabilities. Obstacles to women playing a more active role in forest management include lack of knowledge and technical skills, lack of inclusion in decision-making spaces, and poor recruitment for leadership position. This lack of women's participation and secure land tenure exacerbates poverty, leaves women dependent on common-pool resources and lacking adequate livelihood assets for a sustainable future. Our findings suggest that exploring these issues in a facilitated workshop setting can promote community-level discussion about how to better integrate women in decision-making and leadership of tree-planting activities.

## Session 5. Technology and Innovation: Vision for modern forest management

### New Technologies for Forest Management

Nicholas Coops

*Faculty of Forestry, University of British Columbia, Canada*

A range of new technologies are being utilised for Forest Management globally today, including the operational use of Light Detection and Ranging (LIDAR), growth in Digital Photogrammetry, and use of drones. In addition, new algorithms and increased computing power are allowing forest managers to have access to increasingly rapid and detailed information. A number of these technologies will be discussed in detail.

### Emerging Technologies and Innovations for Sustainable Forest Management in India

Suresh Chandra Gairola

*India*

Scientific forest management in India has a history of more than 150 years. However, with only 2 per cent of world's forests and 18 percent of world's human population, the forest resources are hugely burdened with multifarious anthropogenic pressures resulting in deforestation, forest degradation, low productivity, unsustainable harvests, soil erosion, depletion in hydrological functioning, forest fires, threats to biodiversity and human-wildlife conflicts. Conventional forest management tools have not been able to address these issues comprehensively. Emerging technologies and innovations have now paved the way for much robust approach towards sustainable forest management, enabling the country to address its national goals and international commitments. Development of innovative, locally appropriate tools and technologies for improved ecosystem management of forest landscapes has been in focus in the recent times.

This paper discusses some important technologies and innovations embarked upon by India for forest and wildlife management. This includes precision forestry, forest biotechnology, tree breeding, LIDAR technology, forest certification, bioprospecting, forest landscape restoration, forest valuation, decision support systems, wildlife population estimation, thermal imaging, advanced analytics and mapping for combating wildlife crimes and use of unmanned aerial vehicles (drones). Geospatial technologies including remote sensing, geographic information systems (GIS), global positioning systems (GPS), and spatial modeling has contributed significantly in better forest resource estimation and management. Use of smart sensors for forest protection have potential to safeguard valuable tree species. Cutting-edge technologies have been developed for bamboo products, reconstituted wood, wooden pellets, activated charcoal, wood polymer composites and CNC based advanced woodworking.

Pan-India adoption of appropriate technologies and innovations coupled with capacity building of forest institutions and wood-based industries will make a significant contribution towards achievement of sustainability goals.

## Potential application of using full-waveform LiDAR remote sensing GEDI data with forest growth modelling in deciduous forest management

Rajit Gupta

Laxmi Kant Sharma

*India*

Nowadays, everyone knows forests importance, and many are unmindful about the forest growth and management aspects. Integration of advanced remote sensing with process-based modelling provides an opportunity for improved forest management. Light detection and ranging (LiDAR) remote sensing provide information to characterize the vertical forest structure; therefore, a valuable tool in a range of forests applications. The high cost and large processing time of airborne or terrestrial LiDAR instruments cause limited use of this technology. However, spaceborne LiDAR provides cost-effective capability in understanding Earth's surface features, including forests. Estimating variables such as height and canopy structures using LiDAR data unlocks opportunities in assessing forest dynamics and Carbon mapping.

We recently launched full waveform LiDAR Global Ecosystem Dynamics Investigation (GEDI) data in its potential for forest management aspects using a process-based 3-PG model in the Shoolpaneshwar wildlife sanctuary, India. GEDI provide high-quality measurements on forest heightmetrics, canopy cover and vertical structural information, leaf area index, topography, and gridded above-ground biomass, among other valuable measurements. We used python programming in data downloading, processing and output generation; compared results with 3-PG model outputs, and validation is to be performed using ground truth. Preliminary results revealed that GEDI data useful in forest attributes and inventory generation could be directly beneficial in forest management, and the use of a process-based model helps simulate stand growth and dynamics. In general, remote sensing with a growth model delivers practical outputs for forest management and could be explored to ensure forests sustainability.

## Current Status and Utilization of Plant phytoncides in Forest Therapy

Mei He (1)

Guangyu Wang (2), Yu'an Hu (2), Fangbing Hu (2)

*(1) China, (2) Canada*

Poster Presentation

Forest therapy or “Shinrin-Yoku” refers to visiting a forest or engaging in various therapeutic activities in a forest environment to improve one's health and wellbeing. Due to rapid urbanization, more and more people reside in an urban environment with limited access to nature. With an increasing awareness of the health benefits of forest therapy, it has been implemented on diverse populations. Notably, the research shows that the forest environment directly affects various health indexes of the human body. Among the many forest healing factors, plant phytoncides play an essential role in forest medical care, and the development and utilization directly affect the health effect of forest therapy. As a natural health source, plant phytoncides are a kind of gaseous organic matter that is released by plants in the natural state and beneficial to the human body. Based on the development of forest therapy, this study systematically reviewed the research status of plant phytoncides from

the aspects of origin and concept, the synthetic mechanism and efficacy, influencing factors, collection and detection, and release estimation model. We concluded that plant phytoncides' health value could be a great addition to future parks and great space development.

### Forestry Supply Chain Management System Based Upon Blockchain Technology

Stanislav Horzov

Borys Bakay

*Ukrainian National Forestry University, Department of Forest Engineering, Ukraine*

Forestry enterprises conduct management linked not only to supply of timber, but to objectives, which are set to increase economic functions of forests. It is known that forestry supply chain encompasses all processes that lead from the initial raw materials to a final finished product or services. In this regard, a big necessity in systematic monitoring of this network is required by means of transparency for all business and public participants. We propose to implement blockchain technology, which allows to secure and decentralise the forestry sector.

Proposed supply chain system, which based upon blockchain, has the goal to present overall operational planning and control for ensuring that processes from forest logging to selling of finished product meet the environmental management system requirements in forest industry. A large amount of information will be recorded as digital operations ledger, specifically including: geoinformation data, timestamps, supply chain operations. By introducing mixed cloud-based and desktop computers to store information, the system overlooks all operations, which makes it extremely difficult to change, delete, hack, or cheat because of duplications and distributions across the entire network.

This service planned to provide open results for any person, as information provided through blockchain is reliable and processing of information is automated. Each performed operation, change of ownership or sent query for wood resources from participant will put a print in the system. This approach increases transparency of forest sector by allowing to investigate supply chain elements, which includes all transitions within involved companies.

Proposed solution with usage of blockchain technology delivers transparency and safety in the forest sector. It will become the positive breakthrough in developing more reliable social-economic relations within industry. In overall, the system will deliver a positive change in natural resource management system and protection of environment by achieving strategic goals of forestry sector.

### Mechanical properties and Dimensional stability of Bamboo Fiber Composites for Engineering

Yu'an Hu

Chunping Dai, Mei He

*Faculty of Forestry, University of British Columbia, Canada*

Poster Presentation

Bamboo Fiber Composites (BFC) is a bamboo materials used for outdoor flooring, landscape, engineering construction, which are manufactured by separation, rearrangement, and pressure

forming. It plays an important role in modern engineering composites due to its green raw composites, reusable, easy design and processing, and reliable and stable performance. The mechanical properties and dimensional stability are primarily influenced by the nature of the material (internal cause) and the process method (external cause). This paper characterized the mechanical properties and dimensional stability value distribution (MVD and DVD) within BFC panels and its controlling factors. This study introduces the typical types, main features and molding processes of new-typed BFC. Taking wide bundles of heat-treated bamboo scrimber as a typical case, focusing on comparing and revealing the distribution characteristics and distribution reasons of the mechanical properties and dimensional stability of several typical BFC.

### **Predicting Tree Growth Application Software: an emerging technology for modelling individual tree growth**

Juliana Magalhaes (1)

Adam Polinko (2), Mariano Amoroso (3), Gursimran Kohli (4), Bruce Larson (1)

*(1) Faculty of Forestry, University of British Columbia, Canada; (2) Mississippi State University, USA; (3) Universidad de National de Rio Negro, Argentina; (4) Simon Fraser University, Canada*

Modern forest management involves meeting multiple, sometimes conflicting management objectives. Increased risk and uncertainty associated with climate change is an additional confounding factor in management, justifying that informed decision making uses contemporary data and analysis techniques. In this regard, individual tree growth models that are able to capture the relationship between growth, climate, and intra- and inter-specific species interactions will become increasingly more important. Statistical models like regression are the most common approach to predict stand development through time. Regression models produce simple and understandable relationship between predictors and response variables but are usually not flexible enough to capture complex, nonlinear patterns. Nevertheless, the ongoing evolution of computational tools associated with increased processing power and data availability made possible that computational algorithms become freely available for commercial and scientific applications, such as algorithmic modelling. Modelling with algorithms may require some form of a priori assumption about data format, but one benefit to statistical data modelling is flexibility. Their flexible framework enables learning from data while dispensing most of the statistical premises, such as homogeneity of variance, independence of observations and normal distribution of errors. Predicting Tree Growth is free and open source application software written in

Python 3.7 that is being developed to allow easy and fast development of predictive models using the Recurrent Neural Network/Long Short Term Memory frameworks.

Its simple graphical user interface provides clear tools for building predictive models with the RNN algorithm. RNNs have an upgraded architecture able of capturing tree growth mechanisms related to time ordering and size dependence. In this presentation, we will discuss a case study using the software to predict annual individual tree growth and the potential for incorporating emerging technologies for improved prediction of tree growth in an uncertain future.

## Development of Geospatial database for the permanent sample plots of *Tectona grandis* Lin. F plantation at the university of Ibadan, Ibadan, Oyo state. Nigeria

Kehinde Olagundoye

*Nigeria*

3-Minute Talk

In Nigeria over the years, there has been a challenge of locating most of the permanent sample plots (PSPs) established by institutions after several years of establishment especially when those who know the locations are no more within the system, because the PSPs were not georeferenced. However, this menace was addressed in this study by geo-referencing and developing a geospatial database for the permanent sample plots of *Tectona grandis* at the University of Ibadan, Ibadan.

Nigeria. Data obtained from this study include satellite imagery of the study area obtained from Google earth, available sketch map of the study area. Coordinates of bench mark places and various areas within the plots and plantation, all the available growth data collected from the plots since inception of the PSPs from the records as well as the current year.

The coordinates of all the PSPs were loaded into MS Excel saved in a format that GIS (.csv format) will be able to recognize. This was thereafter loaded into QGIS for the production of a digital map of the PSPs. The coordinates of bench mark places were used to geo-reference the satellite images and further GIS analysis, which include; vectorization, clipping, and map production were carried out. Polygons of different colors were used to distinguish the various plots but different shapes of polygon were used to delineate the plantation. The back and front ends of the geospatial database were created using design templates of BOOTSTRAP comprising of Hypertext Markup Language (HTML), Cascade Style Sheets (CSS) and JavaScripts used in creating websites and web applications alongside with PHP application (formerly Personal Home Page, now Hypertext Preprocessor). The interphase, which is the business logic layer was developed using PHP.

It was observed that most of the PSPs were spatially distributed at the eastern part of the plantation while other parts had no PSPs. The map generated for the study area will aid easy access and navigation within the plantation without the help of whoever established these PSPs. Mean annual increment increased fairly with age while periodic annual increment increased strongly with age. The internet-based database generated was user-friendly, adequate and has provision for updates. Therefore, from this study, it can be stated that GIS is a veritable tool in developing a geospatial database for permanent sample plots of *Tectona grandis* plantation at the University of Ibadan, Ibadan, Nigeria.

## Potential threats upon sustainability of *Myrica esculenta* in north-western Himalayas and emphasis on its conservation strategies by implementation of scientific technologies through village communities.

Smitri Panwar

Girish Chandra, Harish S Ginwal, Maneesh Singh Bhandari

*India*

Poster Presentation

*Myrica esculenta* is an evergreen, wild, dioecious tree species prevalent in the hilly districts of Uttarakhand, India; possessing a remarkable ability of nitrogen fixation. Our study aims to draw attention towards the predicament and dilemmas confronted by *Myrica esculenta* sp. in its wild natural forest habitat.

Our forest survey (2018-2020) was conducted in five districts of Uttarakhand namely- Almora, Champawat, Dehradun, Pauri and Tehri where the elementary focus was accentuated on determination of primary sex ratio among different population of *M. esculenta*. By virtue of the statistical strategy (Stratified Random Sampling, strata corresponds to various districts, where quadrats of 400m<sup>2</sup> were laid following the principle of proportional allocation) adopted we succeeded in ascertaining the primary sex ratio to be 1.45; exposing the fact of male dominated populations. Apart from facing issues of- uneven sex ratio, lesser regeneration (physical dormancy of seeds impermeable seed coat) and overexploitation (for its wild edible fruit), we also encountered magnified impact of anthropogenic stresses on forest biodiversity, had eventually hampered the ecological conditions and sustainability of *M. esculenta*. For the conservation and management, mass scale propagation practices through asexual and sexual methods, appropriate assessment of the incipient and circulation of knowledge ought to be formulated and acquainted among the hill communities.

Forest Department Communities like Van Panchayats can also cooperate in restoring the imbalanced sex-ratio through plantation programmes.

However, distinction of male and female individual's offers major obstruction in the path of restoration programmes has been resolved by exploring and excavating into its molecular biology where we had successfully designed DNA based molecular markers. Administration of our research in laboratory in synergy with the village communities will probably assist in formulating the conservation and management strategies for *M. esculenta* for its in-situ and ex-situ programmes, comprehensively in amalgamation with modulation of genetic components.

## Reimagining Forest Science within Rhetoric of Massive Plantation Program

Vinay Sinha

*India*

Massive tree plantation programs are among the key features of forestry in most developing countries including India. Afforestation and reforestation are imagined as beneficial for the ecological integrity. It is argued that central theme of massive tree plantations has subordinated a comprehensive science-based understanding of forest ecosystem and objective-based forest management program. Vision of modern forest management must look beyond rhetoric of tree

planting, and future planning should be based on robust exploration of resilience and potential of the forest ecosystem meeting social expectations from the resources.

### Status of Wood Identification in Eastern Zone of India

Riya Tudu Solanki

*India*

Poster Presentation

Wood identification is essential for various reasons of processing studies. Wood is utilized by number of different industries in different ways. Wood based panel industries, Furniture industries, Toy industries, Packaging industries, Logistics industries are some industries that utilize wood. There are very few laboratories in India that provide the testing service of Wood Identification to these industries. Indian Plywood Industries Research & Training Institute (IPIRTI) is one such institute that provides Wood Identification test services to the industries. IPIRTI with head quarter in Bangalore and field stations at Kolkata and Mohali, has the facility of microscopic wood identification based on wood anatomy and there is a fairly good demand for this test from various government agencies, plywood companies, lumber suppliers, real estate companies and many other industries that use wood. Demand of this test is such that samples that are received officially at IPIRTI, Field station Kolkata from the eastern and north eastern zone of India constitute to an average of about 87 samples/ year. The data of last 10 years regarding wood identification test requests received at IPIRTI, Field Station Kolkata has been provided. Wood Identification plays a very important role to combat Illegal trading.

### Tapping into historical information for tropical forest management

Sheila Ward (1)

Jenny Wong (2), Gillian Petrokofsky (2)

(1) USA, (2) UK

The history of tropical forests helps us set modern management into context. That history consists of early measurement data for tropical forests (legacy datasets) as well as historical records of disturbance and removals. Much of these data is not widely known or available. Our pursuit of these legacy datasets led us to historical, contextual information – in the experiences of older tropical foresters, in UK university forestry archives, and in many consultant reports in various repositories in the UK.

In this presentation we focus on these various sources of contextual information.

Recent interviews of older tropical foresters with experiences reaching back to the colonial period (ca. 1895-1966) have yielded a new horizon. The countries of experience range from Nigeria (1950s) to the Caribbean to places now under great distress, including Yemen. These foresters have authored valuable memoirs and project reports. Their reports cover in-country forest conditions, management plans, and research on species performance, techniques such as the Tropical Shelterwood System, and many other topics that have continuing relevance.

These lesser-known documents are of critical importance. The most comprehensive archive of documents produced by foresters working in the colonial service administration is on microfilm in the University of Oxford library system. Consultant reports on various post-colonial era forestry projects funded by the UK Overseas Development Agency (under several incarnations) can be found at various repositories in UK university and government departments. Going forward, we hope to interview more foresters who have worked in tropical forestry, both those from tropical countries and those who have served as consultants for international development programs. We also welcome additional sources of historical information for tropical forests.

## Session 6. Conservation vs. Consumption

### 6.1. Conservation vs. Consumption: Indigenous and community forestry

#### Enhancing the potential contribution of Almaciga (*Agathis philippinensis*) Resin Tapping to Indigenous Peoples in the Philippines

Margaret Calderon

Canesio Predo, Kharmina Paola Evangelista, Rogelio II Andrada, Analyn Codilan, Vanessa Palma-Torres, Lawrence Adolph Amada

#### *Philippines*

Tapping almaciga (*Agathis philippinensis*) trees for resin is an important source of livelihood for indigenous peoples in the Philippines. Despite the almaciga resin tapping industry's being over a hundred years old, the resin tappers have remained poor, mainly because of the difficulty of collecting almaciga resin in natural stands, the low prices they receive for the resin and in some cases insufficient resin quotas. The potential of indigenous people's organizations (IPOs) in the provinces of Palawan and Davao Oriental to undertake value-adding activities for resin collected from natural almaciga stands, such as sorting and processing raw resin to refined resin using a melting machine, was evaluated. Breakeven analysis and resource rent estimation were undertaken using different yield scenarios (business-as-usual, low, high) and prices (current and fair prices for raw and refined resin). The value-adding activity of producing refined resin was found to be feasible for the Lumad Almaciga Tappers Association of Governor Generoso (LATAGG) in Governor Generoso, Davao Oriental and Caruray Agricultural Marketing Association (CAMA) in San Vicente, Palawan but not for the Samahan ng mga Palaw'ans sa Amas Brooke's Pt (SPABP), Brooke's Point, Palawan because of its low resin quota. The resource rent under value-adding processing scenario was positive for LATAGG and CAMA but negative for SPABP. Furthermore, the current low prices received by the tappers are not enough to allow them to cross the poverty threshold. Thus, there is a need for a price reform that should properly value the resin tappers' time and effort in tapping and collecting almaciga resin.

*Keywords: Almaciga, Agathis philippinensis, Almaciga resin, Manila copal, non-timber forest product, indigenous peoples*

## Healing the land and pulling our people together”: visions for post-wildfire restoration and Indigenous co-management in Secwepemcúl’ecw, British Columbia

Sarah Dickson-Hoyle

Shannon Hagerman, Lori Daniels

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In Canada and other settler-colonial countries worldwide, there is increasing recognition of the need to advance Indigenous co-management and Indigenous-led approaches to forest restoration. This shift is supported by Canada’s adoption of the United Nations Declaration on the Rights of Indigenous Peoples and stated commitments to reconciliation with Indigenous peoples, including in the context of forest governance. Alongside these commitments to social and policy change, ‘mega-fires’, such those that as burned throughout British Columbia (BC) in 2017, are further transforming social-ecological forest landscapes. Together, these two trends are driving new approaches to forest restoration and management. This was the case with the 2017 ‘Elephant Hill’ fire, which burned approximately 192,000 hectares throughout the heartland of the Secwépemc Nation’s traditional territory (Secwepemcúl’ecw) in interior BC. These wildfires catalyzed Secwépemc communities to action: to advocate for Indigenous-led processes of wildfire recovery and for co-management of their territory. Drawing on collaborative action research with the Secwepemcúl’ecw Restoration and Stewardship Society and its member Secwépemc communities, including interviews with over fifty staff and leaders from Secwépemc communities and the Province of BC as well as over two years of participant observation data, we discuss how the Elephant Hill wildfire created an opportunity to develop a new approach to government-to-government collaboration and land-based wildfire recovery. Our findings indicate the value of this process for building lasting relationships and trust between First Nations and the province. However, diverse and at times conflicting perceptions of ‘success’, and of the meaning and scope of ‘wildfire recovery’, pose challenges to ongoing collaboration. Finally, our findings suggest that advancing true reconciliation and co-management with Indigenous peoples requires long-term commitments and resources to strengthen capacity; fostering shared decision making and self-determination; and supporting Indigenous peoples in exercising their rights and stewardship systems that have been passed down since time immemorial.

## Productivity assessment of wheat (*Triticum aestivum*) and pea (*Pisum sativum*) under *Grewia optiva* based existing agrisilvicultural system in mid-hills of Central Western Himalaya, India

Tara Kumari

Devendra Kumar

*India*

Poster Presentation

*Grewia optiva*, a multipurpose tree species, is widely preferred by farmers in traditional agroforestry systems in the north-west and central Himalayan regions of India. This species is retained deliberately by farmers on the farm bunds on account of its utility as fodder, fuel, fibre and other purposes. The selection of intercrops depends mainly on edapho-climatic conditions of the area and the social factors. The present investigation studies the effect of *G. optiva* based agroforestry system on the productivity of wheat and pea. The study was conducted in three sites. Crops were sown in Rabi

season under rainfed conditions. For the assessment of effect of diameter and crown spread on understorey agricultural crops, quadrats of 1×1m<sup>2</sup> were placed up to 4 m distance from the base of the trees just before the harvest of the crops. Soil samples were also taken at pre and post-harvest to test the soil quality. The study revealed that productivity of wheat and pea recorded highest was in open condition (areas without tree). The yield was minimum at 1 m distance from the tree trunk when compared to the other distances from the tree. Similarly, the number of plants/m<sup>2</sup> was minimum at 1 m and maximum at 4 m away from tree trunk in all the sites. Thus, it was inferred that productivity of wheat and pea crop is significantly reduced in closer vicinity to *G. optiva* trees but soil quality did not show any significant difference.

### Assessing the Pga'knyaw (Karen) rotational farming practice as a form of forest management and tool for land governance: a case study of Ban Klang, Lampang, Thailand

Marie Nosten

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Community land management in Thailand has undergone several phases in the past 5 decades, with the current socio-political landscape fostering greater decentralization to state-level government and increasing participation of local actors in decision making. My talk examines the discourses and practices of the (Pga'knyaw) Karen village of Ban Klang in the province of Lampang, northwestern Thailand whose customary land rights are tolerated by the State. I show that this village is representative of a wider movement in Thailand of grassroots-level advocacy for the recognition of indigenous territorial rights, particularly regarding the protection of traditional upland rotational farming as a means of subsistence. Following the Cabinet Resolution of 3 August 2010, in which the Thai government recognized the cultural and ecological significance of Karen and Lay Indigenous customary land management practices, the Karen strategically link with supportive boundary organizations to establish Special Cultural Zones (SCZ). I explore how these SCZ symbolize a locally relevant form of Indigenous Peoples and Community Conserved Area (ICCA), and are a tool to exercise the claims of customary land rights by communities like Ban Klang.

### The impact of land ownership and deforestation in the Colombian Amazon from 2010 to 2020 on the livelihoods of rural women

Debbie Pierce

*Faculty of Forestry, University of British Columbia, Canada*

3-Minute Talk (Winner, First place)

Colombia contains 10% of the Amazon forest (Field Museum, 2013) and 14% of the world's biodiversity (Global Forest Atlas, 2020), but it also experienced one of the 20th century's longest-standing civil conflicts. Land management and policy, and particularly the unequal distribution of land in the Colombian Amazon, has been a source of contention for decades and is considered a key factor in much of the violence in Colombia (Nelson, 2019). Furthermore, there is increasing recognition of the importance of secure land tenure for reducing deforestation and addressing forest dependent community wellbeing (Bradley and Fortuna, 2019). Much is still unknown about how communities, and especially women, in this region manage their land and forest resources and how their land use

decisions have been impacted by the conflict. I plan to determine how land use and ownership has changed in the wake of the Colombian peace agreement in 2016, and the implications of these changes for the livelihoods of those who live on or have recently returned to this land, particularly women. I will use a mixed-methods approach, utilizing both econometric and survey methods. My research aims to answer the following questions: (1) Has land and forest tenure in the departments of Guaviare and Caqueta changed in the past decade, and if so, what events have caused these changes? (2) How do self-identifying indigenous and non-indigenous women in Colombia rely on land and forest resources for their income and well-being? Has this changed since the passage of the peace accord in 2016? Do any barriers exist for communities to use their land and forest resources to the extent that they would choose? (3) Through which processes have land use changes, such as deforestation through conversion to pasture or agriculture occurred in communities in Guaviare and Caqueta in the past decade?

### Indigenous Tree Borne oil seed: *Diploknema butyracea* (Cheura, The Indian Butter Tree)

Rashmi Sehrawat

*India*

*Diploknema* is a genus of trees, distributed from India to Philippines. *Diploknema butyracea* also known as Indian Butter Tree and locally known as Cheura. It is a large tree of family Sapotaceae. It commonly occurs in the sub Himalayan tract between 300-1500m from sea level. In Uttarakhand, India it occurs abundantly in Pithoragarh district and adjoining areas of Almora, Bageshwar and Nainital district. Cheura (*Diploknema butyracea*) is an important oil seed of tree-origin, distributed from Garhwal, Kumaun eastward to Sikkim, Nepal and Bhutan (Sub Himalayan tracts and outer Himalayan ranges). Oils in kernels known as phulwa or phulwara ghee. Phulwara ghee is used for cooking and frying of vegetables and food. It is also used for preparing medicines, ointment, candles, cream and other user friendly products. The cake produced after processing of Cheura is used as manure. It has pesticide properties and used as wormicide, nematocide, rodenticide and insecticide. The cake can also be used as crude fish poison substituting the dangerous chemical pesticides.

Keeping the above facts in view, the present study was undertaken to develop value added products from cheura kernels and seed skin for livelihood generation of local community. Phytochemical profiling of cheura seeds (kernels and seed skin) was carried out by standard methods.. Detailed analysis will be presented in paper.

### Sustainable harvesting of *Mucuna pruriens* (Linn.) DC. from wild

Sanjay Singh

*Canada*

Commonly known as Velvet Bean, *Mucuna pruriens* (Linn.) DC. is an immensely valuable plant being a good source of food, rich in protein, essential fatty acids, starch, and essential amino acids. However, the main compound of worldwide attention is L-dopa (3-4 % in seeds), an unusual non protein amino acid and a direct precursor to the neuro transmitter dopamine, an important brain chemical involved in mood, sexuality and movement which has been widely recognized for its role in

the treatment of Parkinson' diseases. Wide variability of seed yield (from 65- 110 g/plant to up to 350 g/plant) is seen due to significant variations in seed morphology and active flowering duration (varying from 50 – 180 days) in wild conditions. The L-dopa content among wild collections exhibits significant variation ranging from 3.0 to 5.5 % of dry weight of seeds which is better compared to cultivation (2.0- 4.0 %). When cultivated as a rain fed crop without staking seed yield of 1.5 to 1.75 t/ha has been reported while high yield up to 5.0 t/ha may be taken from well managed irrigated crop provided with stakes. Poor edible attributes due to presence of high levels of L-Dopa have been the major bottleneck for popularization of its cultivation in the farmers' field in India. Thus, sustainability of collection of *M. pruriens* from wild should be the key element of management which primarily revolves around the non-destructive harvesting allowing ample regeneration for future use. The present papers deals with sustainable harvesting practices of *M. pruriens* from wild populations for utilization in herbal medicine to generate livelihood opportunities for forest fringe communities without compromising the conservation of this valuable species.

### Machine Learning - a Prospective Approach for Raw Drug Authentication

Remya Unnikrishnan

Suma Arun Dev, Jayaraj R

*India*

Poster Presentation

DNA barcoding offers a novel prospective tool for taxonomists and a reliable alternative to morphological identification which has greatly transformed the species identification and authentication process. Recently, Artificial Intelligence (AI) based Machine Learning Approaches (MLA) has been reported as precise and automated platform for DNA barcode sequence data analysis for species authentication. In the present study, the efficiency of Machine Learning Approaches (WEKA) was evaluated using DNA barcode sequence database generated from commercially important ayurvedic raw drugs and its market adulterants for authentication. For reference library creation, taxonomically confirmed authentic raw drug species were collected from multiple locations in their natural distribution zones. Likewise traded samples from authorized dealers from south India were collected to check in the extent of adulteration via DNA barcoding and Machine learning sequence analytical approaches. PCR amplified products of standard DNA barcode loci reported from plastid genome (viz. *rbcl*, *matK*, *psbA-trnH*, etc.) and nuclear region ITS (Internal transcribed spacer) were sequenced using Sanger's dideoxy chemistry and multiple sequence alignment was performed in MUSCLE using MEGA 7. In MLA, DNA barcode sequence data analysis is performed with a reference data set composed of DNA sequences of known authentic species (BRM) and query sequence data created with the traded sample sequences. In WEKA adopted algorithms namely SMO, Jrip, J48 and Naive Bayes were tested on DNA barcode sequence data with 10-fold cross validation. The best classifier, SMO could determine the authenticity of traded samples with 100 per cent accuracy. Ability to analyse huge DNA sequence data set with more precision is one of the major advantages of Artificial Intelligence. It also provides a large platform for rapid authentication of species, which subsequently reduces human labour and time. MLA's created specifically for DNA barcoding can be effectively used for species authentication in herbal and ayurvedic drug industries.

## The social value environmental and fire stewardship programs: Insights from Australia and Canada

Renata Moura da Veiga (1)

William Nikolakis (2)

(1) Brazil, (2) Canada

Putting a monetary value on social and cultural outcomes can be a challenging task. However, for building a 'business case' for environmental and fire stewardship interventions, this is critical. In fire stewardship projects that seek to reduce carbon emissions, for example, social outcomes are essential motivators for Indigenous people to engage in such projects, and these are attractive to the carbon market, with a premium for carbon credits from Indigenous fire stewardship programs in northern Australia. The aim of this presentation is to identify the different approaches for measuring social value from these stewardship interventions, often termed Social Return on Investment (SROI), or social value.

Studies indicate that bottom-up approaches generate the most social and cultural benefits for participants in environmental and fire stewardship programs involving Indigenous peoples. These benefits include social cohesion, reaffirmation of traditional identity and intergenerational knowledge transfer, connection to land, and improved physical and mental health and wellbeing, are some of the benefits of fire-carbon programs that drive Indigenous participation. However, these impacts are often so unique that these are difficult to quantify and compare across contexts. However, SROI and social value frameworks are proving to be effective frameworks to measure the social and cultural value produced from these interventions, to report out and compare across different contexts, and to bring these to scale. The presentation will detail the social outcomes generated from environmental and fire stewardship programs, and offer insight for the implementation of SROI and social value measures.

### 6.2. Conservation vs. Consumption: Landscape level approaches

#### Learning from Community-Based Natural Resource Management in Ghana and Zambia: Lessons for integrated landscape approaches

Samuel Adeyanju

Alida O'Connor, Terry Sunderland

*Faculty of Forestry, University of British Columbia, Canada*

Land use in much of sub-Saharan Africa is dominated by legislative frameworks based on colonial history whereby there is a strong focus on state control with very little devolution of management responsibilities to local communities. However, the late 1980s onwards saw attempts to reconcile conservation and economic development through increasing engagement of stakeholders in community-based natural resource management (CBNRM). This paper is based on a review of published literature on historical land-use trajectories and the evolution of CBNRM in both Ghana and Zambia augmented by interviews with key stakeholders in both countries. We ask what lessons can be learned to inform integrated landscape approaches for more equitable social and ecological outcomes? We identify three themes that challenge CBNRM in Ghana and Zambia: inadequate local participation, weak collaboration between stakeholders and sustainability of CBNRM initiatives beyond project funding timelines. We argue that integrated landscape approaches have the potential

to address these issues and urge practitioners to consider how these themes and related lessons learned are being addressed in practice at the landscape scale.

### Customary institutions as entry points for landscape governance: A study in Kapuas Hulu in West Kalimantan, Indonesia

Cut Augusta Mindry Anandi

*Indonesia*

3-Minute Talk

Landscape-based initiatives to enhance conservation and reconcile the interests of various stakeholders have increased globally. Working together and sharing benefits with local communities residing in the landscape is essential for their long-term commitment. However, there is no one-size-fits-all approach to involving local communities considering the heterogeneity among them and different interests, land ownership status, and perceptions of customary land governance regulations. This study aims to unravel the challenges and opportunities of engaging with diverse local communities, focusing on the importance of their customary arrangements. The context of doing so is an initiative that aims to operationalize landscape approaches in two watersheds surrounding the Danau Sentarum and Betung Kerihun National Parks in West Kalimantan, Indonesia.

Based on key respondent interviews in the study landscapes, we found, first, that communities are highly heterogeneous. Different tribes live on communal land, based on kinship, each with their customary arrangements. Second, we found that perceptions and understanding of customary regulations differ across age, ethnicity, and stakeholder group. Third, although customary arrangements persist, traditional customary leaders' role in landscape management is weaker than that of official government authorities. Fourth, customary governance arrangements are eroding due to the influence of external actors. Despite the diminishing role of customary governance in some communities, such arrangements contribute to better landscape governance in other communities, particularly in support of conservation efforts. We conclude that customary institutions constitute valuable entry points for implementing integrated landscape approaches in some contexts.

The research findings highlight the importance of understanding the complexities and context-specificity of customary arrangements in local communities for designing landscape governance initiatives. This study contributes to the debate on the scale of landscape initiatives and the importance of identifying different groups, being open to different interests, and bridging the differences.

*Keywords: landscape governance, integrated landscape approaches, customary governance, West Kalimantan, Indonesia*

## Adaptive potential of teak and its implication on design of conservation strategies in India

Swathi Balakrishnan

Suma Arun Dev, Yasodha Ramasamy

*India*

Poster Presentation

In forest trees, environmental factors shape the population genetic structure and non-neutral molecular markers are commonly employed to assess the genotype by environment interaction. However, when environmental conditions change, selective sweep affects the linked neutral loci along with adaptive loci. Highly polymorphic neutral molecular markers can be employed to assess the genetic variation across populations with varying environmental parameters (changing climate). *Tectona grandis* L.f, a tropical timber tree species distributed in diverse environmental and geographical conditions subject to local adaptations. Here, we investigate the extent of genetic variation and local adaptive potential of teak natural populations in India using genome-wide SSR markers. Whole genome sequencing of teak followed by mining of perfect SSRs with in-silico polymorphism was carried out. Twenty five out of fifty SSRs screened for polymorphism were subjected to SSR genotyping. Statistical analysis was done to determine the genetic variability, genetic structure, allelic richness, and private alleles. We also identified eight probable linked neutral loci from these SSR loci which showed sequence similarity (upstream) with genes responsible for regulating stress, defence, and water response. These eight SSR loci were further subjected to latent factor mixed model (LFMM) to check for association of SSR loci with the environmental variables. The teak natural populations distributed within different geographic and environmental gradients in India showed varying account of allelic richness, private alleles, genetic diversity and population genetic structure. A total of five alleles from two linked neutral SSR loci (linked to genes responsible for drought, salinity and heat stress responses) showed significant association with environmental factors like temperature and precipitation and also identified populations with adaptive potential. Therefore, the teak natural populations/genotypes with higher private or adaptive unique alleles in the country could be targeted for sustainable management, conservation, genetic improvement and resilience of teak genetic resources in the changed climate.

## Impacts of retention harvesting on forest understory vascular plants: dynamics and recovery over nearly two decades in boreal mixed wood forests

Samuel F. Bartels

S. Ellen Macdonald

*University of Northern British Columbia, Canada*

Retention harvesting is touted as an alternative to intensive timber harvesting, such as clear-cutting, to better maintain biodiversity and other ecological values in managed forests. However, it is unclear for how long any potential benefits of retention harvesting continue. We investigated how the responses of understory vascular plant cover, richness, diversity, and composition to a broad range of dispersed retention harvest treatments (2% [clear-cut], 10%, 20%, 50% and 75% retention contrasted with an unharvested control [100% retention]) change with time since harvest, and whether this varies among four dominant forest cover types (deciduous (broadleaf)-dominated,

mixed, and conifer-dominated forest stands). The results suggest a dynamic trend whereby cover, richness, and diversity tended to increase in the short-term (3 years) after harvest, reach peak levels within the first decade (6 – 11 years) and then plateaued or declined within the second decade (17 years) after harvest. But there were still substantial differences in composition among the harvesting treatments, and as compared to the unharvested reference. Generally, response strength scaled with harvesting intensity such that the clear-cut and lower retention treatments (10%, 20%) were similar to one another and remained different from that of the higher retention and unharvest reference treatments, but the specifics varied among the forest types. Our results suggest that retention harvesting, as compared to clear-cutting, had weak and relatively short-lived effects on abundance or diversity of understory vascular plant communities, but could prove beneficial for maintaining and recovering community composition, although the effects vary in complex and non-linear ways over time.

### A Lesson in Resilience - Comparative Analysis of managed and non-managed Mangrove Areas in Jamaica

[Alicia Edwards](#)

#### *Jamaica*

The growing needs of human development significantly influence the vulnerability of mangrove forests in Jamaica. These wetland ecosystems provide critical services that, if lost, would not only jeopardize the lives and livelihoods of many Jamaicans but disrupt many natural and human-made assets. From this perspective, applying sustained and purposeful management to these vulnerable ecosystems should reduce the over-exploitation of their resources. With the need to collaboratively manage this forest cover class, the emergence of the four year-EU Budget Support Programme allows the Forestry Department (FD) to objectively analyse applied interventions and provide current data on the distribution and status of Mangroves islandwide. An imperative control required to assess the validity of applied interventions in this study was achieved through the comparative analysis of areas with established management protection in Portland Bight Area, St. Catherine and non-managed mangrove areas in Falmouth, Trelawny. We used a mixed-method sampling approach to record the physical and health conditions of the mangrove forests and uncover statistical patterns relating to the growth patterns of trees and the impact of artificial and natural elements.

The measured levels at which managed and non-managed areas' resilience to anthropogenic factors and their practical benefits to adjacent ecosystems proved most interesting. The Portland Bight area, with the applied interventions, embodied complete ecosystem management. The management authority uses specific landscape-level approaches to maintain biodiversity through sustainable livelihoods. The non-managed areas exhibit lower levels of adaptability to the pressuring anthropogenic factors affecting their health and conservation. These areas not only showed a high correlation in health factors and regrowth, but they also indicated that the presence of pollutants is directly related to uncontrolled access and removal. Therefore, our observations concluded that when site-based strategies are introduced, the implementation of similar landscape-level approaches to managing these ecosystems positively affects mangrove regrowth and dependent livelihoods.

Reforms needed for British Columbia’s timber supply review process to actively embrace all forest values.

Mike Fenger

*Canada*

Reforms needed for British Columbia’s timber supply review process to actively embrace all forest values.

British Columbia’s timber supply review (TSR) process is a government managed analytical process used by the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) to set the allowable annual cut (AAC) on crown lands in BC. This process assembles a data package, runs modelled timber supply scenarios, and prepares a public discussion paper that the Chief Forester relies upon when setting the harvest rate and preparing an AAC rationale. This is periodically done for the Timber Supply Areas and 34 Tree Farm Licenses and is required under Part 2, Section 8 of the Forest Act at least once every 10 years, with allowance in some cases for a 15 year delay.

This paper questions the lack of reporting and modelling by the Chief Forester on the condition and projected health of the 10 forest values other than timber that are identified in the Forest and Range Practices Act (FRPA). A modelling and conceptual approach that treats all non-timber forest values as “constraints” on timber has persevered since the 1980s, while not reporting on those other forest values. This approach persists despite advances in the mapping and modelling of biophysical resources at landscape scales.

Most of BC (94%) is public land managed by forest product manufacturers and their employees and consultants with minimal government oversight. There has not been a public State of the Forest report provided since 2006, so even at a provincial level the condition of BC’s forests remains unclear.

## A policy and institutional analysis of the constraints to retaining trees on farms in Uganda

Phillip Kihumuro

Eefke Mollee, Tim Pagella

*Uganda*

Poster Presentation

Trees on farms provide an opportunity for landscape restoration globally. They provide benefits ecosystem goods and services to humans at varying scales. Despite the benefits, many countries do not consider them in their environmental and natural resource capital accounts. Trees on farms are left at the periphery of the policy environment, with agroforestry neither belonging to the agricultural nor forestry sector but rather at the intersection. Many tropical countries rely on existing policy frameworks to address components of trees on farms. In some instances, the lack of a clear policy framework acts as a disincentive to maintaining trees on farming systems amongst smallholder farmers. As such, this study sought to answer two questions: a) the policy and institutional constraints to maintaining trees on farms and b) the stakeholders who are essential in the agroforestry landscape within Uganda, with a focus on the Mountain Elgon landscape, Eastern Uganda.

We conducted interviews with relevant stakeholders, reviewed policy and other related documents across Uganda. The results indicated that stakeholders execute their roles with limited coordination; policies operate in silos with some being a disincentive to the others, and that there is lack of clarity on tenure, markets and value chains and the financing modalities for trees on farms. Therefore, to scale up interventions at landscape level, a coordinated policy implementation approach across the sector is needed. Recognition of rights and tenure security for smallholder farmers should be prioritised; market systems for tree products strengthened and formalised and identification and scaling up of innovative financing options for trees on farms where the private sector plays a critical role enhanced.

## Operationalizing landscape approaches in Ghana and Zambia

Alida O'Connor

Terry Sunderland

*Faculty of Forestry, University of British Columbia*

3-Minute Talk (Runner-up, second place)

There is growing recognition global challenges such as biodiversity loss, climate change, food insecurity, and poverty are interconnected issues. This signals the need for a shift from conventional sectorial management to more integrated solutions, and landscape approaches are an opportunity in this regard. Landscape approaches are broadly defined as participatory processes for reconciling competing land uses for improved socioeconomic and environmental outcomes. These approaches are not a “win-win” solution, rather, they provide tools for stakeholders and rights-holders within a landscape to come together and negotiate trade-offs to ‘win more and lose less’. Despite landscape approaches being widely promoted within the conservation and development community, there remains little empirical evidence of the effectiveness of the approach in practice. Over a five-year period, the COLANDS initiative, a collaboration between the University of British Columbia, University of Amsterdam, the Center for International Forestry Research, and local partners seeks to provide

the first comprehensive study of landscape approaches in a selected landscape in three tropical countries, Ghana, Zambia and Indonesia. This study explores the opportunities and constraints of operationalizing landscape approaches in two of these landscapes in Ghana and Zambia. The overarching question driving this research is: What conditions must be in place for collaborative landscape governance to be effective? Preliminary results from a recent national policy review and analysis of existing collaborative natural resource management schemes reveal favourable conditions for operationalizing landscape approaches. However, barriers persist, including inadequate local engagement, weak multi-stakeholder collaboration, and lack of capacity. These findings will guide fieldwork designed to further investigate these challenges. It is anticipated the trends emerging from this multi-site study will help inform implementation and scaling up of landscape approaches elsewhere.

### Growing Trees in Agriculture Landscapes for Sustaining Production and Ecosystem Services in Bangladesh

Md Abiar Rahman

#### *Bangladesh*

Bangladesh is one of the most densely populated countries in the world where over 1200 people live in a square kilometer. Climate change, low forest coverage (about 12%), low land man ration, increasing population are some major challenges. Since there is neither scope for expanding forest area nor sole grain crop area, the country must develop combined production system integrating trees and crops for ecological sustainability. Trees such as *Acacia nilotica*, *Phoenix sylvestris*, *Borassus flabellifer*, *Artocarpus heterophylla* etc. are grown naturally without any specific spacing in crop fields and farmers do not cut the trees. Farmers get a wide range of products such as fodder, timber, fuelwood, molasses, juice, pole, agricultural implements and non-timber products from those trees. For examples, a mature *Phoenix sylvestris* tree produces about 200-250 liter of fresh juice annually. Nowadays, various fruit (mango, litchi, citrus, guava) and timber (mahogany, shissoo and eucalyptus) tree species are planted systematically in different agro-ecosystems allowing sufficient space for arable crops. In an on-farm study, we found that farmer's income increased by 82% when a jackfruit orchard was transformed to multistory agroforestry system. The growth and yield of trees are substantial when grown in agriculture landscapes as they enjoy nutrients and water applied to the arable crops. Although crop yields decrease by 8-12% when grown in agroforestry systems, but it increases overall yields and ensures benefits by providing better ecosystem services. Trees in agriculture landscapes also improves farm environment and increase system productivity. Agroforestry is an integral part of the rural livelihood systems for centuries in Bangladesh and plays a key role in providing household food and energy security, income and employment generation, investment opportunities and environmental protection.

## How change happens in forest landscapes

Jeffrey Sayer

*Faculty of Forestry, University of British Columbia, Canada*

We report on long-term studies of forest landscapes in the Congo Basin and Indonesia. We call our field sites "Sentinel landscapes". We assess their performance against the ability of the forest landscape to deliver benefit flows to societies. Changes in environmental conditions and human livelihoods in these landscapes have occurred gradually interspersed by dramatic changes provoked by unpredicted external events such as financial crises, deteriorations in security and major infrastructure investments. Attempts by government forest agencies, international aid agencies and environmental NGOs have often failed to anticipate or mitigate deleterious changes. Interventions aimed at conservation and sustainable management have been short-term, have responded to issues in the public arena and subject to "issue cycles" where interventions were short-term and focused on single issues. There has been a tension between high level, inter-governmental concerns such as biodiversity and climate change and local livelihood improvement. We are concerned that the capacity of forest stewardship organisations, both governmental and non-governmental has weakened during the periods of our observations. There has been a lack of long-term investment in understanding local human and biophysical contexts and processes of change. We argue for stronger national forest agencies with greater capacity to conduct research on forest and human social-ecological systems. Forest agencies have become more centralised when greater decentralisation was needed. Aid agencies and environmental NGOs have focussed on single issues and their priorities have been set by popular discourses in the media. Fund-raising has prevailed over strengthening in-house competence and commitment to long-term engagement. We advocate greater investments in stronger institutions, more highly qualified staff and deep long-term perspectives. Political level commitments currently being promoted will fail in the absence of competent decentralised institutions. Subsidiarity principles need to apply with decisions made at the lowest level appropriate to address the issue of concern.

## REFLOR-CV – increasing the resilience of local communities to climate change in Cabo Verde

Maria Vasconcelos

Ana Leite, Henri-Noël Bouda, Patrice Savadogo José Castro

*Portugal*

Insularity and semiarid climate make Cabo Verde one of the most vulnerable states to the impacts of climate change. Prolonged droughts have been affecting the archipelago over the past decades, increasing desertification, reducing the area available for agriculture, and shrinking native vegetation to microrefugia sites. More than 70% of the population derives livelihoods from natural resources while experiencing a dramatic combination of decreasing agricultural yields, declining water availability, and high climate variability.

REFLOR-CV promotes a knowledge-based approach for the restoration and management of woodlands, silvopastoral, and forested areas in three islands of the archipelago, favoring the replenishment of groundwater resources. Main activities aim at: a) reduction of soil and habitat loss; b) protection of natural regeneration; c) densification of native vegetation patches in strategic

locations, d) improvement of monitoring and decision-making, and e) exploration of value-added and marketing options for forest products.

The project develops a landscape approach that fosters a cross-sector vision for land use, promoting sustainability and supporting mitigation and adaptation to climate change. As such, the ecological requisites of native or adapted plant species and the biophysical suitability of potential sites are analyzed and conveyed to stakeholders.

Simultaneously, traditional knowledge is incorporated in decision making, with local communities determining the context specific intervention options with the support of technical staff. Accordingly, plants are produced in communitarian nurseries or in household orchards, with seeds and tools made available through the project and localized exchanges.

In addition to inducing an enabling environment, the results of REFLOR-CV, with approximately 800 ha planted in 40 patches and 108 508 plants fixed, including 9 different native and endemic species, have been contributing to increase local adaptive capacity and livelihood quality, while addressing the risks of desertification. 576 men and 842 women are directly involved in the activities.

### Tree species diversity, community composition and recruitment pattern in a critical wildlife habitat of Peninsular India

Thirumurugan Vedagiri

Nehru Prabakaran, Vishnu Sreedharan Nair, Chinnasamy Ramesh

*India*

Protected areas in the tropical forested landscapes support an enormous diversity of unique flora and fauna. However, the existing knowledge gap on baseline information such as the diversity and species composition in the protected areas makes management and conservation a challenging task. We studied the diversity, community composition, and recruitment pattern (seedling and sapling) of tree species in one such protected area- the Moyar river valley landscape (MRVL), transition zone of the Western Ghats and the Eastern Ghats in Peninsular India, which is home for many charismatic species such as Asian elephants and tigers. We used equally distanced nested subplots (10 x10m for trees; 3 x 3m for saplings; and 1 x 1m for seedlings) on a 1 km long transect (n=50), each consisting of ten plots across the five major vegetation types existing in the MRVL. A total of 2599 trees, 1743 saplings, and 903 seedlings belonging to 173 tree species (103 genera and 43 families) were enumerated from the 500 plots. Species richness and composition among the forest types varied significantly ( $P < 0.001$ ), and the diversity pattern for all the five vegetation types followed a similar trend (trees > seedling > sapling). Dry deciduous forests had the highest number of species (n=65), and thorn forest had the lowest number of species (n=29). Riparian forest had the lowest species richness for sapling and seedling. High anthropogenic pressure (e.g., Livestock grazing, NTFP collection, and Firewood collection) and invasive alien species (notably *Prosopis juliflora* and *Lantana camara*) are the major conservation challenges in the landscape. Our study provides the first baseline data on tree diversity and recruitment patterns for MRVL. Therefore, the insights from this study would be beneficial for the habitat management of this critical landscape.

*Keywords: Dry tropical forests, vegetation pattern, Sathyamangalam and Mudumalai tiger reserves, SERB-Funded-EMR/2016/003963*

### 6.3. Conservation vs. Consumption: Conservation valuation

#### Spatial Distribution Modelling of Tropical Forest Types using GIS-based Cluster Analysis

*Yaowaret Jantakat*

Pongpun Juntakut, Chomphak Jantakat

*Poster Presentation*

*Thailand*

Forest area is so essential natural resource and ecosystem services on this world because forests store carbon, preserve soils and water bodies, and nurture a diversity of species. Therefore, this work aims to study Spatial Distribution Modelling (SDM) of tropical forest types using Geographical Information System (GIS)-based cluster analysis. The Nakhon Ratchasima (NK) province of Thailand is study site. The methodology presented spatial clustering analysis (using 2 techniques: cluster and outlier and hot spot analysis) with ArcGIS program for forest types' distribution. This study uses Landsat-8 year 2020 for digital interpreting forest types. The results show that NK area (20,727.35 km<sup>2</sup>) has the highest area of evergreen forest and the subsequent forest types such as deciduous forest and forest plantation. For spatial clustering analysis, cluster and outlier results show the difference of NK-forest areas (four groups: two clusters (HH and LL) and two outliers: (HL and LH). The high-density of evergreen forest (HH clusters) was found in most south-eastern areas (where locates Kao Yai National Park and high elevation) while the low-density (LL) is found in forest plantation at plain. For hot spots-based  $G_i^*$  analysis, hot-spot areas NK-forest areas explored the high density of evergreen forest as same as analysis of cluster and outlier. Interesting, we found the high density of mixed deciduous forest along most riparian areas. This SDM-based clustering analysis of forest types in tropical region is discussed.

#### How do low-cost in-situ soil moisture conservation measures impact ecosystem services in chirpine (*Pinus roxburghii* Sarg.) forest?

Digvijaysinh Rathod

Dinesh Kumar, Parmanand Kumar

*India*

*Poster Presentation*

Integrated landscape management is important to address the problems caused by mismanagement of natural resources which every year lead to loss of 24 billion ton soil and 4.7 million ha forest area all over the world. The importance of soil and moisture conservation cannot be over-emphasised in programmes concerning ecosystem management. A study is being carried out in Chirpine (*Pinus roxburghii* Sarg.) forest in the lower Himalayan region of India for assessment of effectiveness of low-cost in-situ soil moisture conservation structures on soil moisture. Eight treatments of soil and moisture conservation (viz. T1:Shallow ditch-I, T2:Shallow ditch-II, T3:Shallow trench, T4:Earthen bund, T5: Pine needle bund, T6:Earthen bund+ Grasses, T7:Pine needle bund+Grasses, and T8: Control). The treatments were ranked on the basis of average soil moisture content (SMC) to identify the most suitable treatments for pre-monsoon and post-monsoon periods. During the pre-monsoon season highest SMC (22%) was observed in treatment T2 followed by T6, T4, T3 and T7 whereas, during post-monsoon period the highest SMC was recorded in T1 and T5 (32%) followed by T2, T4 and T7.

Interaction of treatment and month in the pre-monsoon period showed the greatest SMC (23%) in T2 in the month of April and while SMC was lowest (17%) in T8 during May. During post-monsoon period, the maximum SMC (35%) was observed in both T4 and T2 treatments and it was lowest (27%) in T8. Taking SMC values of both the seasons together, the inference from the study is that shallow ditches (T1 and T2) are the best performing treatment among all the eight treatments to augment the hydrological regime in Chirpine forest. These low-cost in-situ soil moisture conservation structures would help in rejuvenations of springs, reducing sedimentation in rivers and improving water quality thereby improving the ecosystem and socio-economic status of the people in the Indian Himalayan hill region.

### Linear restoration by happy accident: The influence of forest harvesting activities on seismic line tree and shrub regeneration in upland mixedwood boreal forests

Angeline Van Dongen

Caren Jones, Amanda Schoonmaker, Jill Harvey, Dani Degenhardt

*Canada*

Alberta's boreal forests are becoming increasingly disturbed and fragmented by the cumulative effects of anthropogenic disturbances exacerbated by the enduring footprint of conventional seismic lines on the landscape. Tree regeneration on seismic lines is generally considered to be a slow and inconsistent process leading to the persistence of these linear features which is an environmental and ecological concern as their presence influences predator-prey dynamics. Forest harvesting and subsequent reforestation activities (e.g., site preparation, and tree planting) may facilitate tree growth on seismic lines, effectively erasing them from the landscape; however this hypothesis has not yet been investigated. In this study, upland mixedwood forest regeneration was assessed along transects on and off seismic lines within three cutblocks near Manning, Alberta, as well as on seismic lines in adjacent, mature forests. Results suggest that seismic lines on cutblocks in upland mixedwood boreal forests are similar in tree and shrub development to the adjacent cutblock forest and are thus effectively removed from the landscape 15-16 years post-harvest. Compared to adjacent mature forest, where seismic lines were left to naturally regenerate for a minimum of 34 years, seismic lines on cutblocks achieved similar tree densities and heights 15-20 years earlier. These findings indicate that forest harvesting, as a landscape-level resetting treatment, can play an important role in addressing delayed vegetation recovery on seismic lines. Incorporating seismic lines into nearby cutblocks or targeting areas of high seismic line density for landscape-level harvest and reforestation would be an opportunity to restore linear features in a more efficient and cost-effective manner. Landscape-level restoration strategies facilitated through partnerships between government, forestry, and oil companies should be explored as a potential strategy for removing the footprint of seismic line disturbance from the landscape.

## Conservation of Wild Pear (*Pyrus pyrastrer* (L.) Burgsd.) in Protected Area "Kosutnjak Forest"

Magdalena Jovanovic

Marina Nonic, Mirjana Sijacic-Nikolic

*Serbia*

3-Minute Talk (Runner-up, second place)

Forest fruit trees can be considered as the most endangered woody species in the area of „Košutnjak Forest”, due to their small number, age of trees and sporadic natural regeneration. Therefore, both genes that carry climate adaption properties and biodiversity of this area are at risk. The aim of this research was to determine morphological diversity of wild pear leaves as a basis for further conservation of this endangered forest genetic resource in the protected area „Kosutnjak forest”. Wild pear mother trees leaf samples were collected during the summer of 2019 from 33 selected trees, from the lower parts of the crown, using the method of random sampling. The analysis included 100 leaves from each tree and the total number of measured samples is 3300. Quantitative, qualitative and derived parameters were used for the variability analysis. The obtained data for measuring the morphological characteristics of wild pear leaves were processed in the program „STATGRAPHICS Centurion XVI”. Descriptive statistics (minimum and maximum values, mean value, standard deviation, coefficient of variation), one-factor analysis of variance (One-Way ANOVA) and LSD test were conducted. Based on the obtained mean values, a cluster analysis was performed.

The obtained results of ANOVA show that the differences between 33 wild pear mother trees in all parameters are statistically significant ( $p < 0.05$ ) and that high genetic diversity is present in the wild pear population in the protected area of „Kosutnjak Forest”. Trees 12 and 14 with the lowest mean values, and trees 29 and 30 with the highest mean values for quantitative parameters stand out from the rest of the population and therefore will be used in future ex situ conservation measures ensuring the conservation of biodiversity and genes that will make climate adaptation possible.

## Growth and Sustainability Through High-Density Plantation Management

Anita Tomar (1)

Anubha Srivastav (1) and Dinesh Kumar (2)

*(1) Forest Research Centre for Eco-rehabilitation, India, (2) Forest Research Institute, Dehradun, Uttarakhand, India*

Poster Presentation

Planting high value agricultural crops is not feasible on degraded community and private lands due to soil moisture and fertility constraints. Establishing high-density woody plantation followed by intensive management serve as the key to utilizing such lands productively. This also helps in meeting the needs of the rural communities, especially in degraded land where smallwood and fuelwood are in short supply. Several fast-growing tree species can be used in such plantations. High-density plantations are not raised and managed on a significant scale for production of wood in north India. However, in Southern and Western India and in Europe and North America such plantations are commercially used for production of biomass for pulp and paper industry as well as for bioenergy. They are cut at short intervals of about four years and the wood is supplied to the industry. Wood

chips are made for bioenergy production. The woodlots in India are not managed in this way and hence their productivity is quite low. This practice can be used in Northern India too for production of wood for making pulp, particle board, medium-density fibreboard and as fuelwood. Establishing high-density plantation and their intensive management can be a key for utilizing degraded land productively besides meeting needs of the rural communities, especially in degraded land and hills where wood is in short supply. For present study fast-growing tree species viz. Eucalyptus, Casuarina junghuniana, Gmelina arborea & Melia composita etc. is used in such effort with a three types of spacing viz. 1m x 1m (will have 1000 plants/plot), 1.2 m x 1.2 m (will have 640 plants/plot), 1.5 m x 1.5 m (will have 360 plants/plot). The study aims to develop growth and sustainability by establishing high-density plantations of mentioned species according to site and to study their initial performance.

#### 6.4. Conservation vs. Consumption: National park management

##### Shifting paradigms: Promoting Indigenous Protected and Conserved Areas projects

Jean-Michel Beaudoin

Pauline Suffice, Rosalie Champagne-Co, Louis Bélanger, Jérôme Cimon-Morin, Audrey Vézina-Lavergne

*Canada*

For the past twenty years or so, we have witnessed a paradigm shift in the management of protected areas in Canada, which stems in particular from Indigenous communities' efforts to pursuing greater self-determination. There is a real need to include Indigenous values and needs in conservation planning. This research aims to better understand the challenges of implementing Indigenous Protected and Conserved Area (IPCA) projects in Quebec. More specifically, it has the following objectives:

- Describe Indigenous communities' visions of IPCAs, in terms of values, objectives and needs;
- Understand how to create management tools that are based on their visions;
- Identify the main factors influencing IPCA projects.

This qualitative research, based on multiple case studies, explores new Indigenous initiatives in Québec, namely the Akumunan biodiversity reserve project of the Innu of Essipit, the Pipmuacan of the Innus of Pessamit and Ya'nienhonhndeh protected area the Huron-Wendat Nation. To ensure the quality of the results, we triangulated the information with multiple techniques: documentation, semi-structured interview and participant observation. This research is essential in order to set up management systems that meet their aspirations, on territories managed by them and for them. It will also contribute to the development of a culturally appropriate management.

## Feasibility of developing Almaciga (*Agathis philippinensis*) tree plantations in the Philippines

Analyn Codilan

Margaret Calderon, Rogelio II Andrada, Vanessa Palma-Torres, Kharmina Paola Evangelista, Canesio Predo, Lawrence Adolph Amada

### *Philippines*

The sustainability of producing almaciga resin is challenged by the inaccessibility of the country's remaining natural almaciga stands. This has contributed to low incomes from resin tapping by indigenous peoples in Palawan and Davao Oriental. This paper investigates the feasibility of establishing almaciga plantations to provide additional income streams for the resin tappers while securing future sources of almaciga resin for the industry. Site suitability maps were generated through GIS using critical site factors like elevation, land cover, slope and soil type. The financial feasibility of developing almaciga tree plantations was explored using six (6) scenarios.

The results show that developing almaciga plantations solely for resin production is not financially feasible because of the long waiting time (38 years) before almaciga trees can be tapped. There is a need to combine almaciga resin production from plantations with other production options. The combined results of the financial feasibility analysis and multi-criteria analysis indicate that, with the exception of the resin tapping only scenario, all almaciga plantation management scenarios with carbon, agroforestry, wood and processing options are financially, economically, socially, and environmentally feasible and sustainable options. Developing more accessible almaciga plantations can help ease the pressure on the country's remaining almaciga stands and increase the availability and quality of raw material for the paint and varnish industry through a more efficient production and harvesting system. These in turn will improve the income of resin tappers.

*Keywords: Almaciga, Agathis philippinensis, Almaciga resin, Manila copal, non-timber forest product, silvicultural system, feasibility analysis, multi-criteria analysis.*

## Conservation benefits globally costs locally: A case study of wildlife impact on food security in the adjacent community, Koshi Tappu Wildlife Reserve, Nepal

Nabin Dahal

Kazuhiro Harada

### *Japan*

Conservation of nature and protecting species with enhanced ecosystem services provide benefits to the global community however the adjacent community living around the protected areas are obliged to bear high opportunity cost for biological diversity. This phenomenon is common in the developing nations or states having weak governance with poor economy. We investigated the effects of crop damage by wild animals on the food security of local households and explored potential solutions.

Data were collected through semi-structured interviews conducted with 250 households from three districts (Sunsari-150, Saptari-50 and Udayapur-50) and 21 key informant interviews around the Koshi Tappu Wildlife Reserve, Nepal. Our results revealed that 96% of the respondents had experienced conflicts with wild animals, of which 66% reported rice as a major damaged crop. Annually, 320 kg of rice per household was damaged, which is equivalent to one-third of the annual consumption for

each household in the study area. Wild elephants were the key contributors (62%) to this damage followed by Wild water buffalos (*Bubales Arnee*) and Wild boar (*Sus Scrofa*). To mitigate HWC, 59% respondents suggested construction of concrete walls around the affected areas. In addition, mobilization of the local community in conservation stewardship helps reduce HWC.

### Human-wildlife Conflicts in Banff National Park: Patterns, Trends and Implications

[Christina Geng](#)

*Canada*

Poster presentation

Human-wildlife conflict (HWC) is one of the most prominent issues that has directly or indirectly posed negative impacts on both humans and wildlife in national parks. This research investigated spatial and temporal patterns and characteristics of human-wildlife conflicts in Banff National Park. The data analyses were based on a sample of 6,302 occurrences of HWC within 15 km of the Town of Banff during 2008-2016. The data were processed by using temporal and spatial analysis, hotspot analysis and correlation analysis. Results show a significant spatial characteristic that HWC in the study area had a high risk of occurring along or near the trails or roads, and 96% of the conflicts occurred within a 1km distance from the trails. Townsite activities and driving are two major activities that cause HWC. The animals, such as elk, black bear, grizzly bear and black-tailed deer have a higher risk involved in the HWC within the study area. Results also reveal that both anthropogenic (road density, facility density, visitor number and monthly traffic) and environmental (monthly temperature and rainfall) variables were significantly correlated with the occurrences of the HWC within our study area. The research fills a knowledge gap of the long-term human-wildlife conflict patterns through examining Banff National Park visitor/wildlife incidents and conflict management. The findings can assist both practitioners and scholars in understanding the temporal and spatial patterns and the trend of HWC and conduct effective management on both wildlife conservation and visitor experience and improve human-wildlife coexistence in national parks.

### Seasonal Variation in Visitor Satisfaction and Its Management Implications in Banff National Park

[Christina Geng](#)

*Canada*

Seasonal variations in tourist satisfaction is an important issue for the sustainable management of national parks worldwide. Visitors should have high-quality experiences in both the high season and the off-season. This research investigated visitor satisfaction patterns and determinants in Banff National Park in different seasons. The study was conducted through a face-to-face questionnaire survey that collected visitor demographic, expectation and satisfaction data in July 2019 (high season) and December 2019 (off-season) in Banff National Park. The data analyses were based on a sample of 741 respondents and were processed using principal component analysis, correlation analysis and logistic regression models for different seasons. There were significant differences in visitor satisfaction levels and their determinants in different seasons. The quality of the park's natural characteristics and the park's activities were the most important determinant of visitor satisfaction in the high season and off-season, respectively. The correlation between visitor satisfaction and

expectations in the high season was generally negative, whereas all correlations in the off-season were positive. The results fill a knowledge gap by examining the seasonal differences in visitor experience and their determinants in the national park, and by building a bridge between visitor experience and tourism seasonality. The findings may assist both practitioners and scholars in understanding visitor expectations and satisfaction in different seasons. They may assist in the prioritization and effective management of the park to optimize the visitor experience in both seasons and achieve tourism sustainability.

### Impacts of National Park Tourism Sites: A Perceptual Analysis from Residents of Three Spatial Levels of Local Communities in Banff National Park

Fangbing Hu

Guangyu Wang

*Faculty of Forestry, University of British Columbia, Canada*

Communities next to national parks, known as gateway communities, can benefit from national park development. Gateway communities are unique and limited in the degree to which, and direction in which, they can be developed. In this research, Banff National Park was used as a case study to explore residents' perceptions of the impact of national park tourism via a survey questionnaire distributed in communities at three different spatial levels (core, intermediate, and remote portal). The data analyses were based on a sample of 231 respondents and were processed using factor analysis and linear regression models for different communities. The results identified six impact factors, and the differences in each community were analyzed. The findings indicate that residents' perceptions of the impacts of tourism in the town of Canmore rank first, followed by those of Banff and Golden. The regression analysis revealed that Banff was found to have the most supportive residents, and their support for tourism was found to be significantly affected by community natural environmental factors and cultural development factors. Canmore residents were mainly affected by cultural factors. Golden residents were least supportive due to natural environmental factors and quality of life factors.

An adaptive analysis revealed that Banff has the closest economic relationship with national park tourism, and Golden the weakest. Balancing the positive and negative impacts of tourism, exploring more cultural service functions of the communities, seeking a more diverse industrial structure, planning year-round tourism, and cooperating with other communities to ensure local benefits are recommended. The findings may provide an additional understanding of the local perceptions of tourism impacts and local support from a spatial perspective and can help sustainable tourism management by assisting communities to optimize the tourism industry structure and local management strategies.

*Keywords: tourism impacts, gateway community management, residents' perceptions, Banff National Park*

## The legacy effect of land use land cover changes in forest types of Panna Tiger Reserve, Central India

Kamana Pokhariya

Ajay Singh, Amit Kumar, Chinnasamy Ramesh, Krishnamurthy Ramesh

*India*

3-Minute Talk

Changes in land use land cover over time offer useful insights on the integrity of forest structure and composition and to formulate effective protected area management. It is particularly important in areas that are sensitive to ecological and anthropogenic extremities such as tropical dry deciduous forests. We investigated the effects of historical influence of land use land cover in structuring current forest types in Panna Tiger Reserve (PTR), a human dominated landscape in Central India. Landsat images on decadal intervals from year 1989 to 2019 were classified using unsupervised classification, and a post-classification method was carried out for change detection. Forest types were mapped using 'forest based classification and regression' analysis using Sentinel 2A multi-temporal images, physical variables and field reference points. Land use land cover maps over three decades were classified within six classes, with >80% accuracy. We identified and mapped eight forest types with an overall accuracy of 74.34% and Kappa statistics of 0.63. The results revealed a significant increase in the dense forest class (121.7%), while there was decrease in areas of agricultural land (16.6%), scrubland (43.5%), and open forest (30.1%) between 1989 and 2019. Although the forest area has increased remarkably, ecological and anthropogenic interactions appeared to have caused fragmentation in and around historically forest fringe areas. We conclude that the protected area management strategies including land sparing conservation actions (village relocation) need to weigh the trajectory of the historical impacts and exercise ecologically meaningful choices to maintain the nature and extent of forest types.

*Key words: Change detection, Dry deciduous, Protected area, Spatial pattern analysis, Tropical forests*

## The Impact of Human Interference on Landscape Pattern in the Entrance Community of National Park

Baifei Ren

Guangyu Wang

*Canada*

Qilian Mountain National Park is an important ecological barrier in China, and it also has abundant tourism resources. The "Master Plan of Qilian Mountain National Park" stipulates that entrance communities around Qilian Mountain National Park could mainly develop eco-tourism and nature education, provides special visitor reception services.

Although Qilian Mountain National Park have a high landscape attractiveness, some of these areas are also extremely ecologically sensitive. Under the premise of ecological protection in Qilian Mountain National Park, different communities have different congenital conditions, and consequently they should have differentiated tourism strategies. This study aims to explore the extent to which economic activity should be developed to avoid excessive damage to the eco-space. This study used GWR to analyze the relationship between landscape splitting index and associated

variables of tourism activities and facilities. And find the strongest factors influencing landscape fragmentation in different regions.

The results showed: (1) In Qilian Mountain National Park, from the overall area, the impact of population and economic activities on the environment is greater than tourism activities. tourism activities have a greater impact on the central area of the national park, while population and economic activities have a greater impact on the eastern part of the national park, which is closer to the urban areas. (2) A large number of tourist tracks pass through the core protected areas of the national park, which is not conducive to ecological protection. So tourist activities need to be further regulated.

We make the following recommendations: The core protected area should be re-planned. In the eastern part of Qilian Mountain National Park, there are some entrance communities with development conditions, which can appropriately develop tourism functions, and should be constructed at a lower density, and consistent with the local natural and cultural customs.

### Impacts of Forest Ecosystem Services on Livelihood Security and Sustainability: A Case of Jim Corbett National Park in Uttarakhand, India

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Forest ecosystems play a significant role in ecological sustainability, economic development and livelihood security of people at local level. The Jim Corbett National Park (JCNP) is an important treasure of the Uttarakhand region's natural and cultural heritage. It is part of Himalayan foothills spread over an area about 521 square kms, located in the Nainital district of Uttarakhand in northern India. The Jim Corbett National Park is divided into five major zones (Dhikala, Bijrani, Jhirna, Domunda and Sonanadi), key to ecological sustainability, economic development and livelihood security of local communities. A major challenge to the ecological reliability of national park forest ecosystems is the modification of agricultural, farm, and forest lands to inhabited, marketable or commercial and resort enlargements. The loss of forest cover has given negative effects on human life as loss of livelihood, the source of livelihood like agriculture and livestock is depends on the forest. The study aims understand present status of Jim Corbett National Park, and the level of awareness have impact of forest ecosystem services on livelihood security. The study shows the geographical diversity, social composition of the villages, areas with vulnerability and better practices. The livelihood frame-work of the population under study was analysed for its sustainability according to the rating of the improvement in five types of capital assets viz. natural, physical, human, financial and social, forming the Asset Pentagon. Jim Corbett National Park has played an equally immense role in the sustainable regional development, by providing stimulus to tourism, it brings infrastructural and economic development to the region and considerable foreign exchange to the nation. Jim Corbett National Park activities on the livelihoods of rural residents and forest dependence and forest help to improve their livelihood activities. The establishment and expansion of Jim Corbett National Park has been shown to have different impacts which undermine local livelihood and affect the development of livelihood. Access to resources, especially land, was shown to be sources of livelihood diversification into different activities.

*Keywords: Forest Ecosystem, Livelihood, Agriculture, Tourism, Sustainability, JCNP*

## 6.5. Conservation vs. Consumption: Wildlife management

### Wildlife Management in India: Challenges, Strategies and Perspectives

Suresh Chandra Gairola

#### *India*

India has a rich heritage and tradition of conservation and management of wildlife. Indian mythological scriptures are full of references to wild animals. With only 2.4% of global area, India has about 8% of world's biodiversity with more than 54,500 plant and 91,200 animal species recorded so far. Post-independence, forestlands gave way for developmental activities which took toll on country's wilderness. The challenges include habitat fragmentation and degradation, biodiversity loss, human-wildlife conflicts, wildlife trafficking, lack of integration of wildlife research into management, severe livestock grazing, proliferation of invasive alien species, forest fires and illegal collection of forest produce.

To tackle these challenges, the technical, legal, policy and institutional framework has been strengthened. Central Zoo Authority, National Tiger Conservation Authority and Wildlife Crime Control Bureau have been established. Recovery programme for critically endangered species with schemes like Project Tiger, Project Elephant, Project Snow Leopard have been launched. National wildlife action plan has laid down road map for wildlife conservation. The protected area network is strengthened and it has now grown to 981 PAs including national parks, wildlife sanctuaries, community reserves, conservation reserves besides biosphere reserves, Ramsar wetland sites, Project Tiger reserves, Project Elephant reserves and natural world heritage sites.

Climate change may impact distribution of species, alter habitats and increase extinction rates. Research studies on wildlife biology, animal behaviour and epidemiological surveys are being strengthened. Use of modern technologies like radio telemetry and drones in wildlife management, determining carrying capacities, extension of eco-tourism to non-PAs, capacity building of frontline staff, involvement of non-governmental organizations and creation of public awareness is of paramount importance.

This paper discusses the current and proposed strategies and perspectives to face the challenges in wildlife management in India.

**Urgency of conserving a globally vulnerable tropical medicinal tree: Saraca asoca**

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Poster Presentation

Depleting forest resources has created a vast lacuna in the medicinally important plants. Ashoka is well related to the Ancient history of India. Saraca asoca which is well known for its medicinal properties especially in treating gynecological ailments along with bacterial infestations, blood related diseases, skin disorders etc. The dwindling and scattered population in wild along with unscientific harvesting of bark for commercial and pharmaceutical industry has made the species globally vulnerable. Seed, flower, leaves and roots of the plant are considered therapeutically valuable but bark is highly priced in the commerce with a demand of more than 15,000 metric tonnes in India alone. The tree has been used by indigenous communities and mentioned in age old ayurvedic literature as several commercial S. asoca formulations used for curing different ailments. Owing to the heavy demand asoca bark is heavily adulterated in the market which is only be reduced by creating quality populations. Lack of existing stands in wild and low survivability of seeds by predation are the major hindrances behind natural regeneration in forests. So as to develop conservation strategies of this treasured resource along with in situ and ex situ conservation methods, people's awareness programmes should be conducted based on conservation priority sites for Saraca asoca.

*Keywords: Ashoka, Pharmaceutical value, demand, adulteration, conservation***Multivariate analysis of cranial measurements of Cameroon's Blue Duiker (Cephalophus monticola Thunberg, 1789)**

Miantsia Olivier

Meutchieye Félix, Tsi Angwafo Evaristus, Dongmo Djioisa Francis

*Canada*

Poster Presentation

The blue duiker (*Cephalophus monticola*) is exclusively an African wild bovidae. It is a principal source of protein in the African forest zones and contributes in the nutrition of local populations. Fifteen cranial measurements on 60 skulls using the opportunist's method as from January 2018 to December 2018. Descriptive statistic and multivariate analysis were done using SPSS version 21.0 software and XLSTAT-Pro version 7.5.2 software. It reveals that, there exist a significant difference between males and females skull ( $p > 0.05$ ): total length of skull  $114.32 \pm .81$  and  $121.71 \pm 1.77$ ; Palate maximal width  $35.24 \pm .75$  and  $44.96 \pm 14.80$ ; postorbital apophyses width  $23.34 \pm 1.11$  and  $36.26 \pm 1.79$ ; Palatine length  $55.31 \pm 1.16$  and  $66.52 \pm 1.86$ ; condyle basal length  $96.53 \pm 1.26$  and  $105.43 \pm 3.05$  for the males and females respectively. We have a high positive correlation

between the jugal teeth line length and the total skull length (0.973); between palatine length and the total skull length (0.990) and, between condyle basal length and the total skull length (0.993). The principal component analysis (PCA) enable us to see the level of genetics variabilities of blue duiker through skull measurements. These variables measurement are close together from one to another where there is a high similarity between species. Despite these similarities, the population structure of blue duiker shows three sub-species of blue duiker C1, C2 and C3 found respectively in the agro ecological zones of the Western highlands, Mono-modal humid forest and Bimodal humid forest. These three sub-species varies genetically.

*Key notes: blue duiker, cranial, measurements, skull, Cameroon*

## Butterflies associated with different forest types in Western Himalaya, India

Arun Pratap Singh

*India*

Poster Presentation

Butterflies, amongst invertebrates, are suitable indicators of the environment quality and helpful in identifying ecologically important landscapes for conservation. They are phytophagous, primary herbivores, good pollinators and surrogates of plant diversity. Species prefer particular habitats that are closely related to their different life processes like breeding, larval and adults food resources, etc. Destruction of forest habitats severely affects species abundance and distribution and many species mon become rare. Identification and conservation of important forest landscapes, is thus very important. Indian forest habitats have been classified into different “forest types and sub-types,” based on their similarity of vegetation composition and structure. If the species composition and community structure of butterflies is different in each of these forest sub-types, then each can be considered as an unique habitat or an unit of conservation at the lower level on a spatial scale. This poster depicts 10 major “forest sub-types” found in Western Himalayas in India and unique/indicator butterfly species present in each. These were- 3C/C2a Moist Shiwalik Sal Forest (315826, ha)- Arhopala atrax, Poritia hewitsonii; Grapium nomius ;3C/C2c Moist Terai Sal Forest (54347 ha)- Euripus consimilis, Tanaecia lepidea, Flos asoka; 5B/C1a Dry Shiwalik Sal Forest (35404 ha) - Symphaedra nais; Delias eucharis ; 5B/C2 Northern Dry Mixed Deciduous Forest (67748 ha)-Ixias Marianne, Ixias pyrene, Ypthima huebneri; 9/C1b Upper or Himalayan Chir Pine Forest (627720ha)-Callerebia hyagriva; Hestina persimilis; 12/C1a Ban oak Forest (Quercus incana) (479709 ha)-Euthalia patala patala, Neptis zaida, Euaspa milionia; 12/C1b Moru oak Forest (Q. floribunda) (93169 ha)-Delias sananca sanaca, Rhaphicera moorei; 12/C2b West Himalayan Upper Oak (Q.semecarpifolia)(108660 ha)-Issoria lathonia; Argynnis childreni; 12/C2c Moist Temperate Deciduous Forest (30761 ha) -Meandrusa lachinus, Lethe nicetas, Polygonia comma& 14/1S2 Deciduous Sub-alpine Scrub (19963 ha) - Argynnis jainadeva, Aglais rizana, Hyponephele davendra.etc.

## The economics of endangered species protection in a protected area: the case of Parambikulam Tiger Reserve, Kerala, India

Divya Soman

Anitha V, Syam Viswanath

*India*

Biodiversity loss and species extinction coupled with climate change are global issues that require immediate action. Human behavior in general and economic parameters in particular, help determine the degree of risk to a species. Endangered species form an integral part of the ecological system and are of paramount interest, thus requiring management action for their conservation goals. The governance of biodiversity has a direct impact on sustaining the very existence of life on earth. In the current scenario of resource constraints, the opportunity cost of species protection must be taken into account in the decision-making process while economic incentives are critical in shaping human behavior and species conservation. The present study uses Contingent Valuation Method (CVM) that ascertains the Willingness to Pay (WTP) of the primary stakeholders and compares it to that of the visitors, for the conservation of the endangered species in Parambikulam Tiger Reserve in the state of Kerala, India. The endangered species in this Tiger Reserve were identified and categorized. Following this a semi structured questionnaire survey was conducted to arrive at their WTP and a double bounded CVM was followed to arrive at the conservation importance of the endangered species present in the Reserve. The study highlights the importance of improving biodiversity status that can eventually lead to enhanced ecosystem resilience and contributions towards climate change mitigation and adaptation.

*Keywords: Endangered species, Climate change mitigation, Resilience, Adaptation, Parambikulam Tiger Reserve, Willingness to Pay, Contingent Valuation*

### 6.6. Conservation vs. Consumption: Old growth management

#### Old-growth dynamics in tropical forests of Belize

Nicholas Brokaw

Sheila Ward

*United States*

To conserve old-growth forests we need baseline understanding of their long-term dynamics. We studied dynamics over 25 yr in four 1-ha plots of old-growth forest in a protected area in Belize. Old-growth status was indicated by historical records and stand characteristics. The four plots were within 8 km of each other, and each was in a different forest type: moist upland forest, dry upland forest, riparian forest, and palm/mixed eudicot forest. In each plot we counted and identified all trees  $\geq 10$  cm DBH. Twenty-five years later we re-inventoried the plots. Among plots, the number of trees ranged from 374 to 700 ha<sup>-1</sup> in the first inventory, and the number of species from 46 to 59. During the 25 yr between inventories tree number declined significantly in the dry upland plot but was stable in the others. Mortality (% death of trees in first inventory) among the plots ranged from 25 to 54% ( $\sim 1$ -2% yr<sup>-1</sup>). Recruitment (% newly recorded trees of all trees  $\geq 10$  cm dbh in second inventory)

ranged from 13 to 52% (~0.5-2% yr<sup>-1</sup>). Species numbers remained fairly stable, but a significant number of species were both eliminated from and added to each plot during the 25 years. The decline of tree number in the dry upland plot may be due to the death of long-lived pioneer trees that colonized that plot (in an exposed setting) after wind damage 40 years before the first inventory. The highest mortality and recruitment occurred in the riparian plot, where flooding makes trees unstable, leading to many treefalls and much recruitment in gaps. We conclude that dynamics of old-growth forests differ greatly among different forest types; therefore, we need type-specific, long-term data to distinguish baseline dynamics from novel dynamics caused by climate change or human disturbance.

### Early growth requirements of two central African timber species

Peter Thür

Norgrove Lindsey

*Switzerland*

3-Minute Talk

Bell-shaped population structures have been reported for some tree species in West Africa, indicating poor regeneration. Two valuable tree species with poor regeneration, are *Lophira alata* and *Erythrophleum ivorense*. We explored opposing conjectures as to whether this is due to i) low germination, poor dispersal or predation; II) sub-optimal abiotic conditions or III) human impact. We conducted a systematic review on 27.11.2020 in Web of Science and CAB Abstracts using search strings (“*Lophira alata*”) and (“*Erythrophleum ivorense*”) without further limitations. After exclusion of literature outside the topic area, 40 relevant documents for *L. alata* and 25 for *E. ivorense* were found. Light requirement was the best researched aspect however depended on both the water and nutrient status. We found both higher germination rates and greater dispersal for *L. alata* than for *E. ivorense*. Predation of *L. alata* seeds by rodents was high and losses were doubled where hunting for larger mammals was practiced. For *L. alata*, higher seedling densities were found in medium size gaps (17.5–20m radius) than in smaller or larger ones. Such gaps are comparable in area to the smallest shifting cultivation fields in the landscape mosaic. Similarly, *E. ivorense* had higher survival and subsequent height in cleared rather than underbrushed forest. In controlled experiments, where *L. alata* was grown under optimal soil and water conditions, maximum growth rate was achieved with between 24% and 43% of radiation intensity. Growth was best on low fertility soils. We suggest for *L. alata* to do a thinning in the third year after harvesting.

For *E. ivorense* we suggest cutting down some medium size trees after logging to increase light availability and add scarified seeds to the felling gaps at the beginning of the rainy season.

We expect that this will enhance natural regeneration of *L. alata* and *E. ivorense*.

## Session 7. Urban Forests

### See also Keynotes:

- [The Science & Technology behind transforming Singapore into a City in Nature](#), presented by Kenneth Er
- [Urban forestry and human health](#), presented by Suzanne Mavoia
- [Urban forestry in the era of the Anthropocene: Science, education, action](#), presented by Harini Nagendra

## 7.1. Urban Forests: Benefits

### Access to urban forest lands during the COVID-19 pandemic: influence of environmental factors and reexploring values and functions of forest

Yuta Uchiyama

Ryo Kohsaka

*Japan*

The impacts of the COVID-19 pandemic on access to urban forest, parks, and other green areas were analyzed in this research. To identify the status of access to those green areas, a large-scale online questionnaire survey was conducted in Aichi Prefecture, Japan. The respondents were asked about their status of visiting green areas in the first emergency period (16 April to 14 May, 2020) in Japan. Although the emergency declaration was announced by the national government of Japan, citizens was still able to visit green areas especially near their residential places. There are countries which are implementing strict lockdown policies to reduce the risk of the spread of the virus. In contrast to those countries' policies, the emergency declaration in Japan was relaxed once, and there was no penalty for citizens even if they visited places outside of their residential areas. There were certainly social disputes and confusion as for the extent and perceptions of lockdowns during the period.

The results of the survey show the impacts of environmental factors such as ratios of forestlands in their residential areas. For example, citizens who were living in the places with relatively rich forestlands tended to visit forestlands compared with citizens whose residential places have less forestlands. Citizens' awareness of forest functions differed between citizens who visited forestlands and those who did not. The citizens who visited them tended to be more aware of their therapeutic, spiritual, and educational functions. The values of green area are now reexplored in different regions of the world and some common trends on gender and socio-economic gaps are discussed in academic papers published in 2020 and 2021. Implications for the global trends of the research on green area access are provided in discussion and conclusion of this study.

## To what extent are climate change and urban forestry policies aligned in Canadian cities?

Zhaohua (Cindy) Cheng

Sophie Nitoslawski, Cecil Konijnendijk van den Bosch, Stephen Sheppard, Lorien Nesbitt, Cynthia Girling

*Canada*

While being major greenhouse gas (GHG) emitters, cities also suffer some of the most severe climate change impacts. Urban forests have gained increasing recognition as nature-based solutions to climate change via the various benefits they provide, such as carbon sequestration and temperature regulation. Many cities have developed climate change and/or urban forest policies to enhance climate resilience and support urban livability. However, it is still unclear whether these policies consider and address potential alignment between climate action and urban forest planning and management. This study explored whether and to what extent urban forest and climate change policies are mutually supportive and reinforcing, by conducting a review of climate change and urban forest policies in the largest 20 Canadian cities. Results suggest significant gaps and discrepancies between these policies, across and within study cities, indicating potential weaknesses related to stakeholder/actor engagement, policy integration, departmental collaboration and communication, and cohesive management priorities and practices. Only three (15 %) of the cities have developed climate change and urban forest policies that align to some extent. Furthermore, despite some commonalities, most cities defined their urban forests differently, highlighting locally-specific understanding and needs in addition to a lack of cohesion across Canadian municipalities concerning urban forest planning and management. Across most cities, both types of policies included general and locally-relevant information related to impacts of climate change. However, gaps and inconsistencies found between and within many municipalities' policies may present a major barrier to effective policy implementation and mutually-reinforcing.

## Impacts of COVID-19 pandemic on urban park visitation: a global analysis

Christina Geng

*Canada*

The COVID-19 pandemic has resulted in over 158 million confirmed cases and over 3 million deaths globally, as of 10 May 2021. During the lockdown and restrictions placed on public activities and gatherings, green spaces have become one of the only sources of resilience amidst the coronavirus pandemic, in part because of their positive effects on psychological, physical and social cohesion and spiritual wellness. This study analyzes the impacts of COVID-19 and government response policies to the pandemic on park visitation at global, regional and national levels and assesses the importance of parks during this global pandemic. The data we collected primarily from Google's Community Mobility Reports and the Oxford Coronavirus Government Response Tracker. The results for most countries included in the analysis show that park visitation has increased since February 16th, 2020 compared to visitor numbers prior to the COVID-19 pandemic. Restrictions on social gathering, movement, and the closure of workplace and indoor recreational places, are correlated with more visits to parks. Stay-at-home restrictions and government stringency index are negatively associated with park visits at a global scale. Demand from residents for parks and outdoor green spaces has

increased since the outbreak began, and highlights the important role and benefits provided by parks, especially urban and community parks, under the COVID-19 pandemic. We provide recommendations for park managers and other decision-makers in terms of park management and planning during health crises, as well as for park design and development. In particular, parks could be utilized during pandemics to increase the physical and mental health and social well-being of individuals.

### **Miyawaki Forest – a feasible way to create urban forest**

[Hariharan SV](#)

*Canada*

Poster Presentation

The Miyawaki forestation method is a unique way to create an urban forest and is pioneered by Japanese botanist Akira Miyawaki. It is an afforestation technique that uses native species to create dense, multilayered forests. The overall density of the forest is beneficial in lowering temperature, making soil nutritious, supporting local wildlife and sequestration of carbon in urban areas.

The standard method of planting individual saplings in public areas is problematic in an urban setting. It is disturbed by underground drainage, bad soil quality and overhanging electricity lines, while preparing the area for plantation. These problems could be overcome by planting trees in a group rather than individually. Miyawaki technique includes a six-step process that starts with surveying the soil to assess physical texture, organic carbon, and more. Then a survey of native species is done by visiting and collecting relevant data from the nearest natural forest in the region. After which, native saplings are procured and planted in layers, as per Miyawaki guidelines. Finally, the site is monitored and maintained for a period of 2 to 3 years, after which the sites become self-sustainable. It roughly costs around 1,050 CAD to create a tiny forest of 300 ft & 100 square meter, this method guarantees a high survival and growth rate compared to conventional forests.

A natural forest takes 100 years to grow. But in the Miyawaki method, where plants compete for sunlight, and therefore tend to grow upwards faster than sideways, it is possible to get the same result in around 20-25 years. It will be a reasonably grown forest within 5-10 years, so it is possible to see them take shape in one's lifetime. To be more precise it is like creating mini forests in urban areas.

### **Supporting Role of Green University on The Spatio-Temporal Change of Tree Canopy Cover**

[Yaowaret Jantakat](#)

[Apiradee Muankhamla](#)

*Rajamangala University of Technology Isan; Thailand*

Poster Presentation

Supporting role of green university for well-being and health security, universities should contribute and improve the use and increase of green areas' covering in their areas. Thus, this paper aims to study the spatio-temporal change (between 2011 and 2020 or period 10 years) of tree and cover with Google Earth imagery-based visual interpretation in Rajamangala University of Technology ISAN

(RMUTI). This study highlights two RMUTI-areas where locates in Muang (0.53 sq.km) and Nongraueing (1.76 sq.km sub-district in Nakhon Ratchasima (NK) province. In methodology, this study interpreted tree canopy cover using the recorded Google Earth image and accuracy assessment on ground checking. The results are explored that spatio-temporal change of tree canopy cover for 10 years (2011-2020) in area of Muang has been slightly declined from 27.70% to 26.80% and dramatically reduced from 91.25% to 67.45% in Nongraueing. RMUTI development policy is important factor for changes tree cover in 2011-2020. The case study has benefits for supporting the spatial information to manage trees and green areas including environment in RMUTI further (how tree and other cover types vary and are changing within Muang and Nongraueing of RMUTI is currently unknown).

*Keywords: Green University, Tree Canopy Cover, Geospatial Tool, Google Earth Imagery*

### Urban trees can increase avian and insect diversity and abundance in tropical cities

Norgrove Lindsey

Jaromir Kunzelmann

*Switzerland*

Poster Presentation

Urbanization will continue to be a dominating trend in upcoming decades, threatening habitats, and biodiversity. It is projected that 50% of the population of the tropics will live in urban areas by 2050. Retaining or planting trees in urban areas may mitigate biodiversity losses and potentially provide other benefits such as carbon sequestration, local cooling and reduction of pollution. Yet, there is a large knowledge gap on the potential benefits of urban trees in tropical cities. We therefore conducted a systematic literature review using “web of science” on 27 March 2021 to test the hypothesis that urban trees increase animal diversity and abundance in tropical cities. We initially captured 265 articles, then reviewed them by title and abstract, finally retaining 21 studies. We analysed them using a vote counting system by comparing numbers of significantly positive or negative effects and those where no differences were deemed significant. Studies were from the Americas and Asia, but none was from Africa. The areas assessed in these studies ranged greatly from 80 m<sup>2</sup> to 7854 ha, with a median of 0.9 ha. The two most featured countries were Brazil and Mexico. More than three-quarters of the studies were on birds and for this taxon, the effect of trees was clearly positive. Remaining studies were on ants, bats, butterflies and, also the urban pest and disease vector, *Aedes aegypti*. Nine out of 21 studies found a significantly positive effect of urban trees on abundance, biodiversity, or both. We conclude that there is a research gap on the importance of urban trees for conserving biodiversity in tropical cities, particularly for Africa. Potentially urban trees can increase diversity and abundance of birds, but more studies are necessary on this and other taxa.

## 7.2. Urban Forests: Community engagement

### Living with leopards in a metropolis in 21st Century India

Snowy Baptista

Sunil Limaye, Sunetro Ghosal

*India*

Sanjay Gandhi National Park (SGNP) is a 103 sq km protected area located in the metropolitan region of Mumbai and Thane. According to camera trap records, there are 47 individual leopards (*Panthera pardus fusca*) in the landscape sharing space with an estimated 21,000 people per sq km living in the periphery of the park. This site has a long history of coexistence and conflict between humans and leopards.

A shift in the demography around the park along with improved access to digital technology has made it easier for people to record and share videos and report the presence and movement of leopards.

In order to understand impacts of anthropogenic processes on leopards and to manage human-leopard interactions, Maharashtra Forest Department's SGNP division initiated a project in 2011 called Mumbaikars for SGNP. This is a community-based project that includes representatives of various stakeholder groups. The tools and strategies used by the project have been developed in collaboration with various stakeholders and have enabled a shift from sustaining conflict between humans and leopard to adopting proactive mitigation measures. When the focus shifted from the animal to humans, various stakeholders embraced precautionary measures. Over the years, there has been a significant improvement in the relationship between humans and leopards.

The central thrust of the project is to build a resilient and sustainable relationship between the Forest Department and all stakeholder groups. The project has now become institutionalised within the Forest Department and is driven in equal measures by the forest department and various stakeholder groups. There is important knowledge, theoretical insights and good practices to be gained from this case study of managing human-leopard interactions in the SGNP landscape.

### Most Efficient tree species (Tree Ring) using for monitoring of urban, industrial pollution area, A review

Wagmare Balraju

S.K Tripathi

*Mizoram University, Department of Forestry, India*

Poster Presentation

The worldwide Rapid increases urbanization n and industrialization area due to heavy population growth, with that urban pollution also gradually increasing, it is challenging to the urban green management and pollutant migration. Due to the poor management of industrialization, urbanization from this releasing the effluent is increasing the threat of heavy metals accumulation in the ecosystem. Heavy metals produce from the urban and industrial area it is showing negative affect human health and environment, biodiversity this very serious problem. Trees absorb pollutants from the environment and accumulate them in tree rings (Cocozza et al., 2016; Perone et al., 2018). Sallustio, L., Perone, A., Vizzarri, M., Corona, P., Fares, S., Cocozza, C., et al. (2019). Using this tree

ring we can determine the past history of the pollution trend. The primary advantage of using tree rings for studying changes in the environment is the length of record which provides the baseline data to identify the climatic or chemical changes in the environment due to industrial activity and land-use changes. In this paper present the most efficient tree species which are used in previous research work, what are basic criteria for the selection of tree species, and how to apply the dendrochemical application for efficient management of urban and industrial pollution.

*Keywords: urban, Industry, pollution, tree ring, dendrochemistry.*

## Willingness of Ibadan Residents to Plant Trees to Commemorate Social Events

Oyinlola Fasoro

Opeyemi Ajewole, Rukayat Siyanbola

*Nigeria*

Poster Presentation

Trees in cities contribute significantly to human health and environmental quality, thus, planting trees to commemorate events can be a unique green gift to celebrate people and at the same time restore urban environmental quality. This paper, therefore, examined Ibadan residents' willingness to plant trees to commemorate social events to promote sustainable greening of the metropolis.

A multistage random sampling procedure was adopted to obtain primary data needed using structured questionnaires on 450 respondents from five purposively selected local government areas (LGAs). At 25% sampling intensity, three wards were randomly sampled from 12 wards in each selected LGAs. Two settlements were further randomly selected from each ward and three streets were subsequently randomly sampled from each of the settlements. Thereafter, five respondents were randomly selected from each street, making a total of 90 respondents from each LGA. Data were subjected to descriptive statistics and logit regression analysis at  $p=0.05$ . Results show that 57.8% of the respondents were male, 56.2% were married and 95.3% had formal education. Furthermore, 62.1% affirmed that trees were around their environment; 31.3% identified fruit and food as personal benefits derived from trees, 78.4% agreed that trees are valuable and useful resources, thus, they are willing to plant trees to commemorate social events. Respondents claimed motivating factors for tree planting include: guaranteed investment after retirement (60.5%), knowledge of global environmental issues (67.9%), guaranteed alternative source of income (73.5%) and securing their land from land grabbers (63.5%). Logit regression analysis revealed that age (-0.030) had a significant influence on willingness to plant trees to commemorate social events.

Residents believe tree planting is a good initiative, however, incentives should be provided to enhance individual involvement in tree planting to commemorate social events to improve the greenery of the city and cater for the holistic wellbeing of man.

## Inadequate space for urban forest in India's National Forest Policy - need for review

Ranjit Singh Gill

Cavouright Phanto Marak

### *India*

Edifice of India's present National Forest Policy 1988 (NFP1988) stands on the cornerstone of forest conservation. The strategy envisages, among other measures, the creation of green belts in urban and industrial areas, thus sidelining other aspects of urban forestry. Burgeoning world's urban population brought the need to create a blueprint for healthy cities as articulated by several countries. The UN agenda of 17 Sustainable Development Goals (SDGs) include SDG 11 that aims to make cities and human settlements inclusive, safe, resilient and sustainable through pragmatic measures such as creating green spaces. Malaysia and Denmark started a sustainable forest management program in 2003 with a component aimed at the advancement of urban and peri-urban forests. In China the city of Changchun in 1989 began to carry out a program of developing a 'forest city', thus becoming the first city to have this goal of city development.

India's urban planning has coalesced around the concept of Smart City, an urban renewal strategy which will be implemented in 100 select cities making the urban habitat citizen-friendly and sustainable.

A review of policy is mandated when a vision and strategy need clear articulation to guide future management practices. NFP1988 was born out of the crisis of serious depletion of forest cover attributable to relentless demand for forest produce and inadequacy of protection measures in the erstwhile Forest Policy of 1952. The present crisis of urban health and sustainability of cities represents a watershed moment that calls for public-private partnership in urban forest management. The authors recommend a review of NFP1988 either by way of amendment or the enactment of a separate Urban Forest Policy of India.

## Resident perceptions toward tourism development: a case study from Grand Canyon National Park, USA

Fangbing Hu

Wenqing Kong, Guangyu Wang

*Canada*

Poster Presentation

This article compares the factors influencing residents' perceptions and local support toward tourism in the gateway communities. This study has been conducted in 8 communities that are on the gateway of Grand Canyon National Park. IPA (Importance-Performance Analysis) and SEM (Structural Equation Modelling) have been used to assess the proposed measurements and hypothesis and compare the different relationships among the selected variables. The results of this study identify 4 groups of the factors that influence the residents' perceptions and classified them into 4 stages in the order of management priority. The disparity among the different rims of Grand Canyon National Park has been identified, and the management recommendations were proposed by the authors correspondingly. Through SEM, 5 factors have been verified to be the drivers of local support for national park tourism development, including Community participation (CP), Living environment (LE), Trust of tourism institutions (TT), Tourism Profit (TP), and Community Satisfaction (CS). The findings don't validate the perceived tourism cost as a significant driver. Nevertheless, this study makes a significant theoretical contribution to revealing the relationship between the national park tourism development and the gateway communities' support. Furthermore, this study has several practical implications of community engagement for park managers and local decision-makers.

*Keywords: Gateway community, perception, tourism, community engagement, Grand Canyon National Park*

## How 'shady' are neighborhood trees: modeling Vancouver's urban canopy shading effect

Yuhao Lu (1)

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Cities consume a disproportionate amount of energy for internal temperature regulation. Being able to reduce cities' cooling load in hot summer days can potentially decrease energy consumption while improving occupants' thermal comfort. Urban tree canopy, particularly street trees in a residential neighborhood, is an effective shading agent, adding cooling benefits to existing buildings and streets while providing other ecological and physiological values. Yet, building and street level thermal dynamics are a highly complex system, involving not only micro-level building components (e.g., ventilation, spacing, height etc.) but also macro-level variables (e.g., building locations, street width/density, climate conditions etc.). Introducing urban canopy to such a complex system creates another challenge as urban canopy variable (i.e., species, height, width, solar permeability etc.) can also interact with buildings at both micro- and macro-levels. In order to accurately represent urban canopy shading effect, it is necessary to account for the interactions among buildings, streets, and urban canopies. This study simulates the shading effect of urban canopy in Vancouver, British Columbia through the integration of a Radiance engine and aerial laser scanning (ALS, or commonly

known as LiDAR). The results are able to provide an authentic 3D urban canopy assessment from single building to city scale, creating new opportunities to investigate intra-city urban canopy variations for planners and urban foresters.

### Context-specific Urban Forest Management: A Citizen Science Approach

Syamili Manoj Santhi (1)

Afthab Faisal Katakath (2)

*(1) India/United Kingdom, (2) Germany*

Urban forests are regarded as an integral component of all sustainable cities as they are the primary suppliers of ecosystem services. However, there is a need to conceive urban forest from a socio-cultural perspective where people are an integral part of nature in which both are inextricably linked. A rapid literature review was conducted for a period from 2018-2021 in Web of Science on urban forestry. Among the recent 100 publications, 40% dealt with the ecological perspectives of urban forest cover while social dimensions covered only 8%. This vast number of ecological studies on urban forests would result in the mere planting of trees amid gray areas by city planners. The potential of the urban forest in reducing stress and ensuring mental health and wellbeing has recently become a hot topic of discussion among the scientific community during the pandemic. However, a dearth of academic evidence is experienced in the socio-cultural aspects of the urban forest. A case study from India demonstrated that the existing religious and cultural context helped preserve urban forests around temples in several cities. Felling such religious trees and the degradation of the pristine environment were considered taboo by the local people. Therefore, the local people were the guardians of such green patches, which behaved like the urban forests. While in sub-Saharan African, the context is different. Food security was the pressing issue, and the people preferred urban forests with fruit trees. These studies highlight the significance of the participatory approach in urban forest planning and management. People's preferences will provide critical insights for the city planners, which may vary with the region, culture, context, and mode of use. Therefore, a citizen science approach would offer the residents their rights to choose and manage the urban forest in their surroundings by facilitating city planners.

Saskatoon's Hidden Forest- An afforestation project now a laboratory in ecological succession and a valuable urban forest on the Prairies.

Robert White

Julia Adamson

*Canada*

Saskatoon, located in the Grassland biome, has a contiguous, man-made, mixed-wood forest, totalling 474 acres, within its boundaries, which began as a unique greenbelt afforestation project by the City of Saskatoon (CoS) with planning starting in 1971. Approximately 200,000 native and introduced trees and shrubs were planted as part of the "Green Survival Program". Until recently, this laboratory in ecological succession was on the fringe of the city and illegal trespass and dumping were taking place. Beginning in 2016, a citizen-led advocacy group began mobilizing community

action to protect and value this asset by spearheading community clean-ups and conducting and publishing research on the rich natural and cultural heritage of the site, which also includes wetlands and some species at risk. This effort served to draw both public and city hall attention to the area. The city is now expanding around this area and in 2019 developed a Green Infrastructure Strategy which will ensure the valuation of this major asset. These values include mature trees, carbon sequestration, ecosystem services, biodiversity, eco-museum potential, place-based science and environmental education, and having a large, semi-wild, forested terrain for various forms of recreation and spiritual recharge. Fortuitously, a 326-acre block was named after the inspirational forester Richard St Barbe Baker (1889-1982) whose innovations in community forestry beginning in the 1920s established the International Tree Foundation. The Friends of the Afforestation Areas plan anniversary celebrations; 50 years since the greenbelt plan and 50 years since Baker received an honorary doctorate from the University of Saskatchewan for his lifelong conservation activism. Furthermore, celebrating that through conservation valuation and community engagement, a stewardship ethic is replacing degradation and a valuable urban and regional park is no longer hidden.

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**Session 8. IUFRO Divisions 6 and 9: Social aspects, forest policy and economics**

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**8.1. Livelihoods**

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**Impacts of scientific forest management practices on forest user's livelihood- A case study from community forest in Lumbini Province Nepal**

[Sudha Adhikari](#)

[Kazuhiro Harada](#)

*Japan*

Scientific Forest Management (SFM) is the systematic application of forestry science knowledge to manage forests, based on the correct assessment of attributes of forest crops to maximize and sustain benefits, following a silvicultural system. SFM is perceived as a potential option for improving productivity and harnessing the true economic potential of the forest resources, implemented on 2014 in Nepal. The traditional approach of community-based forest management in Nepal were more focus on forest conservation rather than economic outcome. This study explains the changes on forest user's livelihood and their participation on forest management activities after the implementation of SFM practices in the community forest. Annual documents review, key informant interviews, 150 household interviews with field observation were carried out to know the changes after SFM practices. The study showed that income of the community forest fund doubled than before by selling forest products (timber, fuelwood, bark). Using these funds, loans were distributed with less interest rate to the forest users for cattle rearing, vegetable farming and starting small local business for their daily income generation. More people were employed as a daily wages labor, forest watchers for controlling forest fire and illegal timber poaching. Also, scholarship for poor students, roads and bridge were constructed through the community forest fund, which showed the positive impact on the forest users' livelihood.

Involvement of technical experts in forest management process as per SFM guidelines resulted in low involvement of forest users in decision making process. This study revealed that economic benefit out shadowed forest users right. Effective participation of forest users in decision making is essential in any forest management effort to make it sustainable, as they have direct contact with the resources.

**Bamboo industry development for poverty alleviation: What works?**

[Lucy Binfield](#)

*Canada*

Bamboo, a fast-growing woody grass that grows across the tropics, has received considerable attention in recent years due to its potential as a sustainable, versatile material for a huge array of projects. Bamboo grows in some of the world's poorest regions and has been identified by many governments, international organisations and researchers as a tool for poverty alleviation through industry development. However, many top-level initiatives to support communities in bamboo-producing countries to plant, manufacture and process bamboo appear to have failed, positive case studies in the research literature remain isolated, and many data on the subject is anecdotal. Here,

preliminary results of a systematic review and searchable database of bamboo industry development initiatives will be presented, focussing on the measurable impact of such initiatives and on the use of non-traditional (non-financial) indicators for social impact assessment in this field.

### Producing cassava foods and drinks, re-producing Indigenous society in Guyana

Janette Bulkan

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The continuing centrality of cassava to the ontologies of the Makushi and Akawaio, two of the nine surviving Indigenous Peoples (IPs) of Guyana, is the focus of this presentation. The critical roles played by women in cassava-related processes and social practices are outlined. Makushi cassava nomenclature, the combination of vegetative and sexual propagation techniques, and the wide networks for exchanging stem cuttings reflect the fundamental importance of bitter cassava to both food security and their worldview that embraces the interrelationship of all living beings on the land. Examples of the reciprocal accountability among humans and cassava plants are given. Women continue to take primary responsibility for processing the poisonous root into food and drink and also possess greater knowledge of landraces. Cassava also remains central to Akawaio ontologies, reflected in the areruya system of belief. In the annual eki siku, ('young cassava festival'), the value of cassava and of women is affirmed in the sacred texts and transmitted in visions through prophets, many of whom are women. Cassava cultivation and cassava-related rituals remain central to the Indigenous social systems. These are not simply livelihood practices but also ritual and spiritual acts by which Indigenous Peoples enact and maintain relationships within an environment where everything is sentient.

### Misalignment of households revealed and stated tree-species preferences for firewood in the South of Chile and implications for native forests

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As a primary domestic energy source for the vast majority of households in developing countries, firewood extraction accounts for roughly 50% of global forest extraction (FAO, 2019). There have been few in-depth quantitative studies on household preferences and choices of tree species used for firewood despite its importance in driving forest degradation. This is particularly important in Chile where fuelwood is provided by a mix of native forests and plantations and fuelwood preference has implications for native forest protection. Against this backdrop, the main objective of this study is to investigate the revealed vs. stated tree-species preferences for firewood and the factors influencing household choice behavior. Species-specific attributes (e.g. wood quality, cost, accessibility), as well as socioeconomic and demographic characteristics, influence household preferences for different fuelwood species. We used a cross-sectional survey of 621 urban and rural

households in the Los Lagos region of Chile collected in 2020. We used generalized ordered probit models to investigate the determinants of actual species choice from ranked preferences complemented by a multinomial logit/probit model analysis of revealed preferences for tree species categories. Nearly 90% of households used firewood consisting of 24 different tree species from native forests and/or tree plantations (mainly *Eucalyptus* sp.). While the majority ( $n = 425$ , 76.6%) of the households consumed a single species (though not always the same one), multi-species consumption was also common ( $n = 130$ , 23.4%). Slightly over three-fifths of households consumed a tree species that aligned to their stated preference. However, 35.5% consumed a non-preferred species and 3.5% did not state their preference. Roughly one-fourth of the households used exclusively four high-value native species [*Eucryphia cordifolia* (Ulmo), *Amomyrtus luma* (Luma), *Tepualia stipularis* (Tepú), and *Nothofagus obliqua* (Hualle)]. Households' revealed preference for these species represents a significant pressure on some native forest ecosystems, which increases forest degradation. Another 16.6% used exclusively the genus *Eucalyptus* sp. (mainly *Eucalyptus nitens*) creating incentives for plantations of this exotic species. By understanding factors influencing household choice behavior, this research can contribute to improve regulations aim to promote more sustainable consumption decisions among Chilean households, better regulate local firewood markets, and strengthen the ongoing energy transition process.

*Keywords: fuelwood, native species, exotic species, preferences, household surveys*

## Economic and environmental prospect of NTFP GIs in Japan: Empirical analysis of Joboji Urushi

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The production of non-timber forest products (NTFPs) has been expected to attain the dual goals improving the livelihood of forest dwellers and contributing to the conservation of biodiversity. However, the economic and environmental effects of the production continue to be in question. Ministry of Agriculture, Forestry, and Fisheries of Japan introduced Geographical Indications (GI) on agricultural, forest and fishery products including NTFPs in 2015. GI designates the products with specific characteristics to the production region and intends to improve the economic viability of the producers for their sustainable production based on local landscape and tradition. Thus, this study explores the prospect of NTFP GIs in Japan for economic revitalization and environmental conservation. Additionally, this study discusses how the GI registration interacts with discourses to affect the quality of NTFP. For this purpose, this study focuses on the effects of the registration of Joboji Urushi in Ninohe City, Iwate Prefecture. The main method of this study was a series of interviews with the executive and staff members of the producer associations and staff of related local government offices from 2019 to 2020. Joboji Urushi was registered as GI product in 2018. The application did not emphasize the standardized production methods but the diverse quality of urushi by producers and natural conditions. After the GI registration, the sales opportunities of urushi product increased besides the increasing demand for cultural property preservation. Additionally, the city and the producer association furthered the maintenance and expansion of local urushi forests for sustainable forest use responding to the increasing demand of urushi. This involved companies in other sectors, schools, and other organizations. Thus, though the result is preliminary, GI has the

relatively positive prospect to achieve the dual goals to improve the livelihoods and conserve forests through registering NTFPs including urushi and charcoal.

### Income distribution and inequality analysis within the Conversion of Cropland to Forest Program: a case study from Jiangxi, Shaanxi, and Sichuan provinces in China

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Conversion of Croplands to Forest Program (CCFP) is one of the environmental protection policies implemented in China after disastrous climate events in the late 1990s (e.g. the drought in the Yellow River Basin and the floods in the Yangtze and Songhua River Basin). The CCFP operated in 25 provinces and reached 32 million households, becoming the largest reforestation-based Payment for Ecosystem Services (PES) program in the world. While the program resulted in the conversion of 25 million hectares of croplands on steep slopes or otherwise ecologically sensitive areas to forests or grasslands, the long-term success of reforestation efforts also requires participants to realize socio-economic benefits. A number of studies have been conducted on CCFP looking for changes in income level or livelihood structure but the majority of the works are rather limited in space and time. In addition, little has been done to understand the impact of the program on inequality. To provide further insight, this work investigates income distribution and inequality before and after 12 years of implementation of CCFP on a sample of 908 rural households in Shaanxi, Jiangxi and Sichuan. Households level data were collected by local forestry agencies and state government organizations.

We examined the change in inequality within the sample and compared the three provinces to investigate the relationship between program implementation and inequality change. The role of different income sources in inequality generation was better understood through a concentration coefficient analysis of livelihoods. Finally, we analysed the income level of households after the implementation of the program to investigate the contribution to income inequality of different socio-economic.

### Socio-economic impact of tree Pests and Diseases in Nakuru County, Kenya

Angela Muthama

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*Kenya*

Pests and diseases affect tree physiology leading to undesirable effects on tree growth and wood properties. Effects of disease and pests' attacks on trees include leaf spots, blight, leaf falls, shot holes, cankers, root rots and in extreme cases death of trees. 50 small-scale to medium level tree farmers were interviewed on the impact of tree diseases on their livelihoods and income. The majority of the households represented in the survey were male led with highest level of education being high school. The disease and pest attack symptoms recorded were drying up of trees, root rots and cankers on cypress and eucalypts wood lots and boundary planting. Most farmers (70%) were not aware that the malformations were from attack by pests and diseases. The major costs incurred

in the management of the attacks arose from control measures such as chemical application for aphids and canker pathogens. Another major cost for those who owned tree nurseries was pre- and post-emergence damping off of seeds in the seed beds. An average loss of Kshs. 130000 ( $\pm 10566, 0.03$ ) was incurred in death of trees and pruning of affected branches in trees. Farmers with higher education recorded different responses to the occurrence of pest and diseases in that they consulted extension officers upon noticing problems on their trees. The study gives a justification for tree breeding for pest and disease resistance for exotic tree species in the country which are the ones mostly used in commercial forestry programs. It also necessitates proper species site matching to reduce physiological stress to trees thereby minimizing susceptibility to pests and diseases. Forestry extension services are key to the success of any tree growing enterprise from seed purchase all the way to post harvest operations. The economic impact necessitates establishment of proper integrated pest management programs in Kenya.

### Economic Analysis of *Bambusa balcooa*, *Dendrocalamus stocksii* and *Bambusa tulda* in subhumid regions of Peninsular India

Sruthi Subbanna

Syam Viswanath

#### *India*

Since the past decade, there is an increase in bamboo cultivation in farm forestry. This is a resultant of awareness of growing bamboo species along with an increased availability of micropropagated plantlets. With this increase in growing bamboo species, in this paper, we have examined the economics associated with growing two bamboo species commonly grown in the subhumid regions of Peninsular India viz. *Bambusa balcooa*, *Dendrocalamus stocksii* and *Bambusa tulda*. Three factors Benefit to Cost (B/C) ratio, Internal Rate of Return (IRR) and Net Present Value (NPV) have been calculated. Results indicate the ratio is positive at 4.36, 3.75 and 3.23 at 8%, 10% and 12% discounted rates respectively for *B. balcooa* at planting density of 1000. These values were observed at 4.41, 3.74 and 3.19 for *B. balcooa* at planting density of 600. For *D. stocksii* the values were much greater at 6.84, 5.75 and 4.88. *B. tulda* although profitable itself too, was marginally lower than other two species with B/C Ratio at 3.75, 3.26 and 2.85 respectively. The values can also be deemed high for *B. balcooa*, wherein IRR was calculated at 32 percent and 30 percent for planting density 1000 and 600 respectively for a period of forty years at all three discounted rates. *D. stocksii* showed the highest IRR at 40 percent. NPV was calculated at ₹17,85,900 (\$24,381) and ₹14,52,677 (\$19,832) for *B. balcooa* at planting density of 1000 and 600 respectively at 10 percent discounted rates. NPV value was much greater for *D. stocksii* at ₹21,12,477 (\$28,839) at planting density of 600. Values of NPV were found to be lower than the other two species for *B. tulda* at ₹ 14,71,657 (\$20,106). The study indicates that all three species are beneficial to farmers in the order *D. stocksii* > *B. balcooa* > *B. tulda*.

## 8.2. Traditional knowledge

### The appreciation of traditional forest-related knowledge as a starting point for future development - a case study of Austria

Elisabeth Johann

*Canada*

Rural areas with a long history of activities that integrate forestry into farming activities have created a biodiversity that is closely connected to landscape patterns. At international level, this close relationship has been stressed by the UNESCO-CBD Declaration on the Linkages Between Cultural and Biological Diversity 2014, stating that “the European landscape is predominantly a biocultural multi-functional landscape”.

These cultural landscapes are composed of fields, meadows, fruit trees and, in large parts, of forest. The EU-Action Plan 2006 acknowledged cultural landscapes, traditional practise and other cultural values of forests as some of the ways of achieving local and regional sustainable development. Landscape values are also included in the new Common Agricultural Policy (CAP) and the European Landscape Convention. Even these cultural landscapes are considered to be a development factor these potentials have only partly been investigated till now.

For some years now there has been an increasing interest among forest owners in new markets and additional income beside forestry and an increasing interest of tourism in the use of forest areas and beautiful landscapes. At present numerous initiatives, collections and museums exist; however, they are often not adequately linked. Thus, a co-operation of forest and tourist enterprises including the awareness-rising of traditional knowledge and the forest related cultural heritage can be considered as a new approach to promote rural development.

The study analyses the interrelation of sustainable forest management and the safeguarding of the forest-related cultural heritage in Austria. It tackles social conflicts and agreements and investigates what kind and to what extent traditional forest related knowledge and practices concerning nature and traditional craftsmanship are still relevant. Thus, also options are discussed in which ways the revitalization of this knowledge could contribute to the strengthening of rural areas.

### Reconstructing the historic fabric of Belgrade Forest (Istanbul) through its toponyms as a means to revitalizing conservation and restoration efforts

Simay Kirca

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*Turkey*

Heritage values of landscapes that include cultural traditions, intergenerational use, livelihood systems, and aesthetic and spiritual meanings are waning under increasing land conversion and climate change. The concept of landscape authenticity has been proposed as a useful way to examine the specific natural and socio-cultural dimensions of landscapes and interpret their historical importance for conservation and restoration planning. Drawing from these and related ideas in historical ecology, we focused on the case of the ancient Belgrade Forest in Istanbul (Turkey). As a major water source for historic Istanbul, the forest was well-protected from the Neolithic age through

to the Byzantine and Ottoman Empires. However, despite the enduring perception of its importance, Belgrade Forest is undergoing unprecedented and rapid shifts in land use and structure.

Acknowledging change as an inherent landscape characteristic while focusing on historic fabric and key elements of the past, our research addresses two main questions: (1) How might archival data help to reveal landscape authenticity? and (2) How have different historical actors perceive and interact with the landscape? We compiled a set of historic maps and narratives of Belgrade Forest and surrounding areas, and produced a database of toponyms. With qualitative text analysis and digital mapping methods, we developed a typology of place meanings, and mapped their relationships over time. Our results reveal a diversity of meanings embedded in the landscape, and how emerging data visualization techniques can help communicate this heritage. This may support the documentation and revival of traditional land-use practices and the design of restoration/conservation schemes. For future research, we propose using a variety of qualitative and quantitative approaches to analyzing diverse data sources. Such a broader view can help integrate the values of the past with the future needs of society, while offering valuable insights for connecting historic preservation with sustainability movements.

### Cassava agrobiodiversity in the Guiana Shield: ecocultural resilience, global implications

John Palmer

*Canada*

This presentation examines the cassava agroforestry system that has evolved in South America since the root tuber *Manihot esculenta* (Cassava, *Mandioca*, manioc) was domesticated probably in central Brazil over a thousand years ago. Cassava is now the third most important source of carbohydrate in tropical regions after rice and maize. Cassava is unique among major tropical crops in being deadly poisonous in the raw state for the bitter landraces that contain the toxic cyanide. The factors are outlined that explain why the Indigenous Peoples of the Amazon and Orinoco regions preferentially propagate hundreds of bitter varieties, and not the easily-available 'sweet' or non-toxic varieties. I summarise the process used by Indigenous citizen-scientists to study new landraces and incorporate desirable ones into their farming system.

I demonstrate the inter-relationships among the hyper-local and transnational range of cassava cultivation and show how and why in situ cultivation and exchange of new landraces by Indigenous farmers provide local to global ecosystem services. Locally, the small-scale rotational agriculture is carried out in small 1-hectare plots on a 30-year cycle that enriches the Amazon forest. Globally the evolution which we need for climate resilient-agriculture is almost entirely in the hands of these Indigenous citizen-scientists who are not paid for this service.

### 8.3. Certification

#### New Roadmap and Destination - SFI Urban Forest Sustainability Standard

Paul Johnson

*United States*

This presentation will quickly set the stage for the evolution of urban and community forestry and the synergy of bringing SFI into the urban and community forestry sector. In the vein of Urban FIA, we're actively blurring the lines between urban forests and traditional forests. Our trees, air, water, and associate macro and micro flora and fauna don't recognize political boundaries. Forest certification has helped us increase sustainability and marketability of our forests and we're bringing similar tools to urban and community forests.

SFI is working with Arbor Day Foundation, American Forests, International Society of Arboriculture, Society of Municipal Foresters, and Trees Canada to develop the SFI Urban and Community Forests Sustainability Standard and the resulting certification program to further drive the evolution and recognition of our forestry programs across the US, Canada, and beyond.

This is likely to be one of the first opportunities that participants have to learn about and participate in the review and development of the standard. This presentation will work virtually and will be appropriate for many segments of the forestry sector including municipal, utility, non-profit, and commercial entities.

Learning Objectives: Attendees will be able to understand how standards and certification works, participate in the development and review of a new standard, evaluate their urban forestry program, and test the draft standard.

#### Assessing how the beneficiaries perceive the constraints and benefits of FSC certification: a case study of Brazilian smallholders planted forests

Juliana Lima de Freitas

*Canada*

Forest companies around the world have implemented Forest Stewardship Council (FSC) certification to promote responsible forest management and mitigate negative logging impacts. FSC can help companies meet legislative requirements while improving market access, increasing revenue, and showcasing their sustainability policies. For Brazilian small landowners, who are dependent for their livelihoods on immediate sales of forest products, the principal motivation for pursuing certification is achieving market benefits (Bulkan, 2020).

Recognizing that third-party certification costs are high for small enterprises, FSC published a specific standard for Small and Low Intensity Managed Forests (SLIMFs). Still, smallholders continue to face financial and technical challenges in getting certified. In this context, some large Brazilian companies that desire to increase the percentage of certified wood in their products promote incentive-based programs for their small suppliers who are willing to be certified. These partnerships usually consist of a premium price for the timber, technical support, and a stable market.

Despite the alleged benefits mentioned previously, it remains inadequately addressed if and how the social, environmental and economic outcomes of forest stewardship models, like FSC certification, can promote efficient flows of benefits among local stakeholders and transform inequitable and non-sustainable scenarios (Bennett et al., 2015). This study aims to assess the benefits and constraints perceived by smallholders and their employees regarding the certification process to fulfill this gap. The results may better inform smallholders, increase their engagement and expand the certification benefits accordingly (Lima et al., 2009).

#### 8.4. Policy

##### **Nudge: On Enhancing Adaptive Capacity and Reducing Vulnerability Levels**

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Nudge theory emphasizes on positive enforcement and indirect suggestions as ways to influence the individual or group behaviour. This behavioural economics concept contrasts with other alternative measures of legislation, like penalties or incentives. Utilising beneficial norms as positive influencers, changing the available options for people, usage of reminders and reinforcements are some of the applications of nudge theory. It is effective as an instrument of public policy or as part of government actions to implement their adaptive capacity building strategies.

Considering the marginalised forest dependent tribal community of Western Ghats in Kerala, India, the present Community Based Vulnerability Assessment study found them to be highly vulnerable to the climate change induced drought in forest. In this comparative study of two tribal settlements with similar exposure and sensitivity indices, variation in adaptive capacity values crucially affected the aggregate vulnerability level of each settlement. The Settlement-2 had several capacity building initiatives under the Panchayat (rural local self-government), which had applied nudge theory in influencing the people's choices regarding employment, marketing, education and self-awareness. Adaptive capacity was evaluated based on human, natural, financial, social and physical parameters. The settlements had highest adaptive capacity regarding social aspects, and least with respect to financial and physical factors. Settlement-2 had better social and human adaptive capacity, which substantially lowered its vulnerability score.

The study recommends the application of nudge theory in the implementation of well-planned capacity building strategies for empowerment and infrastructural development based on a settlement specific community based approach.

## Governing innovation and knowledge sharing to increase the adaptive capacity of forest industry in Quesnel, British Columbia

Adinda Herdianti

*Emilio Valeri, Rebecca Riggs, Christopher Gaston, Jeffrey Sayer, Agni Boedhihartono, Erin Robinson, Lacy Scuffi*

The British Columbia forest sector is under pressure to respond to changing global demands and to improve benefit flows from forests to local communities. Innovation towards advanced engineered products and new bio-products is becoming increasingly important for realizing the full potential of forestry in the province. In Quesnel, British Columbia, efforts to stimulate innovation and diversify actors in local forest industries can be challenging for emerging locally-driven forest enterprises that have limited capacity and resources. Building an inclusive forest industry “ecosystem” comprised of existing large and small forest enterprises therefore involves strengthening networks of knowledge and innovation. Here, the concept of innovation includes both technological aspects of production and the governance processes that allow for adaptive and collective problem solving and knowledge sharing across actors in forest industries. Understanding the Quesnel social landscape of innovation is crucial to achieving consensus among actors on the transition pathways that ensure improved benefit flows from forest industries to local communities. This research seeks to gain a deep understanding of relationships amongst Quesnel forest industry and to identify conditions that foster innovation. To meet this objective, we apply a participatory approach to actor network analysis in Quesnel. Stakeholders identify their position of influence in the network and their role in the knowledge sharing process. Preliminary results from this process will guide large and small forest enterprises, decision-makers, and other actors in the development of an inclusive, diverse, and adaptive forest industry in Quesnel and British Columbia.

## Impacts of forest environmental tax and multi-level collaboration: toward sustainable forest management scheme in Japan

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*Japan*

Under the depopulation and aging trends in rural areas, forestry workers and its market size are shrinking. Because of that long-term trend, abandoned forestlands are increasing rapidly. To support forest management in this difficult situation, enhance carbon stock, and reduce the risk of natural disaster, Japan introduced a national forest-environment-transfer tax (FETT) in 2019. Local governments of prefectural and municipal scales receive the tax revenue and implement tailored policies for their individual local forestry and forestland situations. In addition, they need to disclose how the revenue was used. There is an existing forest taxes at 37 prefectures and those prefectural governments need to explain how to demarcate the uses of their taxes and national-level tax. Considering those circumstances, we conducted questionnaire survey for prefectural governments which need to support municipalities with less human resources and budget. We surveyed (1) status of use of FETT, (2) supporting bodies for municipalities, (3) guidelines to support municipal forest management using new forest management systems, and (4) exchange of staff members between prefectures and municipalities. The result shows certain correlations between implementations of those policies and the prefectures’ attributes such as revenue size of FETT and the number of

municipalities within each prefecture. Because of the introduction of FETT, implementation of forest management at municipal level is facilitated, although there are management issues which need to be solved by the collaboration between prefectures and municipalities. Especially, municipalities with limited experience of forest management need intensive support by prefectures. There are municipalities where forestry is not active, but the certain amount of abandoned forest exists and adequate forest management is urgently needed. The evaluation of effect of FETT on multi-level collaboration need to be conducted in the future research.

## International Political Economy of the Lacey Act Amendment of 2008

Hang Ryeol Na

USA

Behind the stated goals such as combatting illegal logging, there was a political and economic aim of the Lacey Act 2008. The underlying objective of advancing the US wood industry in the global market has been fulfilled since 2008, as evidenced by the increased US export of forest products, the decreased import, and job creation. The legislative process of the Lacey Act 2008 also reveals that it was targeted at foreign competitors, especially Chinese hardwood and plywood trade, even though the investigation by US International Trade Commission failed to offer any conclusions on whether or not Chinese manufacturers used illegally logged woods as a cost advantage.

Lacey Act 2008 is considered one of the major global forest governance tools such as EU FLEGT, supported by conservation groups, much of the domestic wood products industry, and a bipartisan coalition of interests. Enforcement of the law places the legal harvesting burden of proof on the supply chain from the countries of origin, in many of which indigenous people live dependent on forests, to importers, who are required to report suspected violations to the US government. Hence, unintended consequences of the law include that it hurts indigenous communities living in forests, as many laws do not recognize their native rights to natural resources. Also, there can be unfairly increased liability on small businesses in the US involved in the import of wood products to monitor the world's forests to prevent illegal logging activities.

## Broader Participation Needed to Allow Forest Policies to Address New Challenges

Emilio Valeri

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We have studied changes in forest policies in Indonesia and British Columbia. Many policies focus on generating government revenues, creating employment, and regulating the environmental impact of large-scale forest industries. These policies were negotiated between governments and industries with some input from environmental interest groups. Today forests are required to provide a much broader range of social and environmental goods and services, notably climate change mitigation, biodiversity conservation, and improved livelihoods for rural forest-dependent communities. Broader participation in developing policies is necessary to meet the needs of an increased number and

diversity of interest groups. Yet forests often exist within contested landscapes where there is tension between interest groups with conflicting agendas. Participation in developing policies often leads to competition dominating decision-making processes. The “tug of war” between managing forest for national goals and managing for local livelihoods is one result of such competition. Local aspirations for economic growth or development can conflict with central government’s ambition to halt forest degradation and meet global environmental goals. Our research aim is to explore how policy networks can be strengthened to develop policies that allow forests to provide a wider range of benefits to a wider range of actors. Using the case study of Quesnel, British Columbia, we identify the position and influence of forestry actors in policy networks to explore how mutual understanding could serve as a basis for reconciling conflicting objectives. I explore how policies that enable a system of checks and balances and mutual monitoring could lead to forest governance that benefits a broad range of social actors and forest ecosystems.

### The State of Canada’s Forests Amid Three Decades of Sectoral Transformations

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Natural Resources Canada is mandated to table to the Parliament each year a report titled “The State of Canada’s Forests”, which presents highlights of the Canadian forest sector’s main activities during the year. Using information from the series of annual reports of the past 30 years, this paper provides an overview of the major trends in the forest sector, in terms of the contributions of forests to the Canadian economy, society and the environment. Canada’s forest sector has evolved from a nationwide affirmation of sustainable forest management (SFM) as a predominant principle in the 1990s to the creation in 2008 of a national vision aspiring to become a global leader in forest sector innovation as well as SFM. More recently, forest industry transformation and climate change have been embraced as top priorities for federal, provincial and territorial governments, companies and private woodlot owners. The process of realizing the forest sector vision has benefited from perspectives provided by First Nations, civil society and the science community. Meanwhile, the vision has been enriched by additions of new elements such as urban forests. A broad spectrum of partnerships involving businesses, non-government organizations, resource professionals as well as forest-dependent communities is essential for the forest sector to stay its course and continue to meet Canadians’ growing expectations on the significant role of forests.

*Keywords: Climate change, economics, innovation, sustainable forest management, transformation*

## 8.5. Social aspects

### The internal migration and forestry policies in Peru

Cristina Miranda Beas

*Peru*

The internal migrations in Peru, a South American country of 32 million inhabitants and one of the 12 megadiverse countries in the world (MINAM: 2019), constitute one of the most influential historical processes for the Peruvian society. As of 2015, one in three Peruvians lived in a district other than their place of birth (Sanchez: 2015), so understanding migration patterns contribute not only to the understanding of national employment trends (Yamada: 2010) but also to the underlying processes linked to the land use such as forest use, one of the main drivers of deforestation.

Throughout the Peruvian territory, forests occupy more than half of the total extension, approximately 56.9% (MINAM: 2016), it has 55 indigenous peoples and the whole country is divided into 25 regions and 1874 districts, which implies an extensive geographical, political and cultural complexity. In recent years official documents and publications from the government agencies in the forestry sector such as the Forestry Investment Plan (MINAM: 2013) and National Forest and Climate Change Strategy (MINAM: 2016) scarcely mention the influence of migratory phenomena on the use of natural resources.

In that sense, this research, based on documentary analysis and interviews, analyzed the perceptions of decision-makers and policymakers on the importance of migration regarding forest use and its influence as one a deforestation driver. It also identified sources of information used to support these perceptions and tentative strategies for improving information sources based on informants' opinions.

The evidence found shows the challenges related to migration governance which are based on the application of planned migration policies that aim to contribute to the improvement of forest management and reduce deforestation.

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### Insights into employers' attitudes and behaviors regarding Indigenous workforce diversity

Jean-Michel Beaudoin

Delphine Théberge, Hugo Asselin

*Canada*

In Quebec, the natural resources sectors are affected by a scarcity of labour. At the same time, many Indigenous communities want to more fully participate in their region's economy. In this context, a multidisciplinary research team led by Professor Jean-Michel Beaudoin of Laval University conducted a study to better understand the factors that influence Indigenous participation in the labour market.

A survey was conducted among 127 employers in the Quebec forest sector, including 18 Indigenous employers. In addition, interviews were conducted with employers in the forestry, mining, and

fisheries sectors to document their attitudes and behaviours towards Indigenous employees, as well as their practices to promote the cultural diversity of workers. The study findings identify possible solutions to create a culturally relevant and safe environment for Indigenous workers, including personalized follow-up, the implementation of a mentoring program, or the hiring of liaison officers who can assist in community recruitment, labour relations and career advancement. It is also necessary to contribute to intercultural bridge-building by providing training on Indigenous realities and cultures to all employees. While contexts vary from one sector to another, the results show that the recruitment, integration and retention of Indigenous employees is positively influenced by the fact that a business is owned by Indigenous peoples, by partnerships between businesses and communities, and by legal and judicial obligations.

With the results from this study, which are summarized in a table of good practices, it is now possible to design more effective measures for the recruitment, integration and retention of indigenous workers in the natural resource sectors.

### Implication of national forest and land legislation and property rights of customary leaf litter forest (Sokshing): Case from central Bhutan

Ratan Gurung

Kazuhiro Harada

*Japan*

In Bhutan, forest resources were traditionally managed by local institutions before the government intervention. However, with the implementation of the Forest Act of 1969 and Forest and Nature Conservation Act of 1995, government expropriated the customary ownership of sokshing (Leaf litter forest) from the local people and bestowed only the usufruct right for leaf litterers. Further, the Land Act of 2007 ended usufruct right of sokshing land owner through deregistration from national land register (Thram). This could alter the incentives for long-term sustainable use, management and protection of sokshing forest. Thus, this study interviewed 61 households with structured and semi structured questionnaire including both sokshing forest owner and nonowner to determine the implication of these legislations in sokshing forest management and use. To examine the changes in the forest property right, Ostrom and Schlager's bundles of rights' framework was used. The research revealed that despite the deletion of legal ownership of sokshing forest by the national laws, rights of the forest is strongly determined by customary laws. It was found that the sokshing forest being an inherited property and indispensable for agriculture livelihood support, strongly motivated people to conserve the forest. However, majority of the respondents revealed that the lack of clarity in property right and implementation of the policies, has created uncertainty and confusion among themselves. Respondents are more anxious for the protection of their hereditarily managed forest due to the loss of their legal authority. Thus, for sustainable conservation of sokshing, providing tenure security and management right would play a fundamental role.

## Evaluating state responses to gender inequity in community forest governance, Uttarakhand, India

Madison Stevens

Malika Viridi

### *Canada*

Women have been central to grassroots struggles for forest rights worldwide. This is no accident: women disproportionately depend on forests for subsistence, participate in the day-to-day activities of resource gathering, and bear the burden of caring for the commons. Yet they often remain marginalized from leadership in forest governing institutions due to patriarchal patterns of inheritance, gendered division of household labour and capital, and longstanding cultural norms. In Uttarakhand, India, amendments to the legal framework governing van panchayat community forests attempt to address these inequities in decision-making, through changes which reserve forest council seats for women (2005) and mandate that council leadership (sarpanch) alternate by gender (2012). Yet it is unclear whether these responses by the state have resulted in substantive gains for women in decision-making or merely contribute to visible metrics for success in "women's empowerment" while institutional inequities persist. Indeed, these same amendments have considerably weakened the authority of forest councils by recentralizing power in the hands of State agencies, thereby undermining community conservation efforts. Drawing on longstanding experience in van panchayat management in Johar Valley, Uttarakhand (Malika Viridi), and in-depth, open-ended interviews conducted in 2019-2020 (Madison Stevens), we examine the gendered nature of forest rights and stewardship responsibilities in van panchayats. We ask, when governing the commons, in what circumstances does it matter whether the decision-maker is a woman or a man? Are stewardship strategies and successes gendered? Does the response of the State, manifest in regulatory changes that purport to foster women's representation in governance, effectively address gender inequities in access to forest resources and the burden of labour associated with forest stewardship? We explore these questions as they pertain to diverse governance approaches across the commons landscape, and offer policy recommendations for improving gender equity in forest governance in the state of Uttarakhand.

## Understanding social diversity in Canada's forest sector through quantitative data

Stephen Wyatt

Maureen Reed, John Boakye-Danquah

### *Canada*

Canada's forest industry contributes about 24 billion dollars to Canada's gross domestic product (GDP) and employs about 205,000 people. The sector faces a labour shortage, with industry advocates expressing concern about the lack of young, skilled workers. However, focusing on these workers overlooks opportunities to enhance representation of groups such as women, immigrants, and Indigenous people. The 2016 Census reported that 17% of workers employed in Canada's forest sector were women, compared to 14% in 1996. Proportions of immigrants and Indigenous people do not reflect their presence in the overall population – the first is much lower and the second is slightly higher. We examined labour force data from Statistics Canada to identify regional and sub-sector trends in employment for these three groups and to explore variability in who is employed, how they are compensated, and the security of their employment. This analysis confirms challenges faced by

these groups, but also highlights very different patterns for each group. For example: women face a persistent and significant wage gap, but this is much less significant for immigrants and Indigenous peoples; paper manufacturing employs more immigrants than Indigenous people but Indigenous workers have a higher median income than non-Indigenous; and Ontario has a higher proportion of immigrant workers in forestry than British Columbia, although the proportion of immigrants in the population is similar.

Unfortunately, census data do not allow us to determine why these differences exist, nor to propose policies or interventions to reduce structural barriers or encourage diversity. We discuss key gaps in the availability of regular, reliable, verifiable, and disaggregated quantitative data that could contribute to monitoring and explaining trends. Finally, this quantitative study highlights the need for in-depth, qualitative studies that can support changes in policies and practices for a more diverse, inclusive, and innovative workforce.

## 8.6. Indigenous Forestry

### Managing forests for culturally significant plants in traditional Cherokee homelands

Michelle Baumflek

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*USA*

The Eastern Band of Cherokee Indians (EBCI) and the USDA Forest Service are engaged in an integrated approach of research and action to manage forests for culturally significant plants within portions of traditional Cherokee homelands. The effort seeks to develop, plan, and implement forest management policies and activities that support the traditional arts, diets, and practices of the Eastern Cherokee while at the same time promoting integrated forest stewardship over a larger landscape managed by the EBCI and the United States Government. The focus area is western North Carolina and portions of adjacent states, and includes the Qualla Boundary (EBCI tribal lands); the Pisgah, Nantahala, and Cherokee National Forests; and the Great Smoky Mountains National Park. This presentation explores how synergistic efforts to date contribute to a long-term platform for sustainable harvesting and improved ecological conditions for culturally important plants. Here, a platform is conceived of as long-term institutionalized change across policies, practices, and governance at different scales. Building on interrelated approaches to adaptive collaborative management with Indigenous peoples at the landscape level, we find that key features of platform building in our context include responding to Indigenous priorities, fostering quality relationships, community engagement and co-producing knowledge.

### Fairness and the implementation of a collaborative forest management agreement: The case of the Adapted Forestry Regime in Eeyou Istchee (Cree territory), Quebec, Canada

François-Xavier Cyr

Stephen Wyatt, Martin Hébert

*Canada*

Indigenous peoples around the world have long struggled to maintain their self-determination and their rights, turning variously to courts, protests, international organisations, private business, and

mobilizing allies. In Canada, the Cree nation has been particularly successful in asserting its rights, negotiating new treaties, gaining compensation packages, winning judicial battles, establishing business ventures and forcing the provincial government to modify its laws. But these actions remain unequal struggles and it is not always clear if their winding paths are really moving forward. In this presentation we examine the complex processes created since the “Paix des Braves” agreement of 2002, which sought to establish a more collaborative approach to the management of forest and other resources on Eeyou Itschee, the Crees traditional land located in the province of Quebec, Canada. The Adapted Forestry Regime (AFR) of the Paix des Braves agreement is widely considered an important stepping-stone in the long process of involving Indigenous peoples in the management of forestlands in Canada. This study is based on an analysis of key processes that have been part of the implementation, and factors in the evolution of the AFR since 2002. Examining these processes shows the complexity of implementing such an agreement, allowing us to consider different styles of collaboration established to resolve issues and also to evaluate the fairness of these. While the Crees have obtained additional powers for forestland management through the AFR, our analysis demonstrates that the complexity of this process leads to close intertwining of political and technical issues, which often become conflated with others. While both Quebec and the Crees have had to compromise on numerous issues, our analysis finds that ultimately, it is the Crees who bear the heaviest burden of the compromises that must be made implementing this collaborative process.

### Following a Lil'wat approach towards reciprocal and relational forestry research

Tonya Smith

*Canada*

The Lil'wat First Nation, in British Columbia, Canada, is pursuing opportunities in the forestry sector as a pathway towards self-determination. Lil'wat Nation forestry follows a community-centered model, wherein community and cultural impacts of forestry are considered and weighted equally alongside economic and environmental impacts. To meaningfully engage with Lil'wat community members about their Indigenous Ecological Knowledge (IEK), the Lil'wat Nation's forestry company has partnered with university forestry researchers to create forest management plans based on IEK.

All research with the Lil'wat Nation is required to follow the Lil'wat Nation's own research protocol. The Lil'wat S7i'tsken Research Protocol prioritizes community interests and the protection of Lil'wat intellectual property within research by providing guidelines for moving towards respectful research relations rooted in Lil'wat values. The S7i'tsken Protocol is intended to safeguard against harmful and extractive research practices, which characterized much of the earlier research done with the Lil'wat Nation by non-Indigenous researchers. This presentation will explore the teaching and learning concepts of the S7i'tsken Research Protocol and how they were applied in forestry research featuring IEK. Following and learning from the protocol both constructively challenges conventional research processes and enhances outcomes for forestry research.



The End