CFA Newsletter

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The 20th Commonwealth Forestry Conference: A Reflection of Our Times

The 20th Commonwealth Forestry Conference will be unlike any other in its 100th year history. For the first time ever, delegates will be able to join the Conference virtually from their home locations throughout the Commonwealth and beyond to share forestry knowledge and experience.

The Conference, held every 4–5 years, was originally slated to next occur in Vancouver, Canada. However, due to the Coronavirus-19 pandemic, organizers decided to hold the conference online to ensure the safety and convenience of all participants. It will still be organized from Vancouver and through the University of British Columbia, and you will have the opportunity to get some online experiences of the forests and forestry activities that are so characteristic of this area.

"We are welcoming the general forest community from government, industry, academia, and other civil and environmental organizations from all corners of the globe, and, thus believe it is the wise and responsible choice to hold the Commonwealth Forestry Conference virtually in 2021. It will make planning easier and more certain for the delegates, and open up some exciting, new opportunities for information sharing, participation and connection that in-person conferences simply cannot offer," says Dr. John Innes, Commonwealth Forestry Association President and Dean of the Faculty of Forestry at the University of British Columbia.

The Commonwealth Forestry Conferences originated a century ago and were the precursor to many of the global forestry meetings we see today. The Conferences have brought widespread awareness of forest resources around the globe, and introduced strategies for their use and long term sustainability. Today, the Conferences have a strong reputation as global forestry events that bring together a wide representation of forest practitioners and natural resources managers, scholars, decision makers, and change influencers.

"We are in an era of both great change and vast opportunity. We are extremely excited about celebrating 100 years of advancing forestry knowledge through the Commonwealth Forestry Conferences. At the same time, we are looking forward to the many possibilities that future Conferences will bring," remarks John Innes.

The Conference will be held online between August 16–19, 2021. **Please visit cfc2021.ubc.ca for more information.**

Association News

We need your experience!

In partnership with the International Society of Tropical Foresters (ISTF) we are asking if you have 1) experiences of your work in the tropics that you would be willing to share with colleagues, or 2) tropical forest data sets in need of long-term curation.

1) We are also asking our experienced members if they might be interested to talk to in-country foresters via Zoom or Skype about their experiences of working in forest management in their country.
2) The hunt for legacy tropical forest data is being headed up by the IUFRO Working Party on Forest Data in the Tropics (https://www.iufro.org/science/divisions/division-4/40000/40200/40201/). You might know of legacy tropical forest data sets that are still on paper or in older digital formats. Such "orphaned" tropical forest data have many uses. The goals are to locate more of these data sets, develop policy for appropriate acknowledgement and credit, and get them digitally curated and available for research. More information can be found at https://www.researchgate.net/project/Legacy-tropical-forest-datasets.

If you think you might be interested in sharing your experiences with in-country foresters or sharing legacy tropical forest data or, then please contact us at cfa@cfa-international.org

Forest Scenes

Developing a common vision for forests and the forest sector in British Columbia

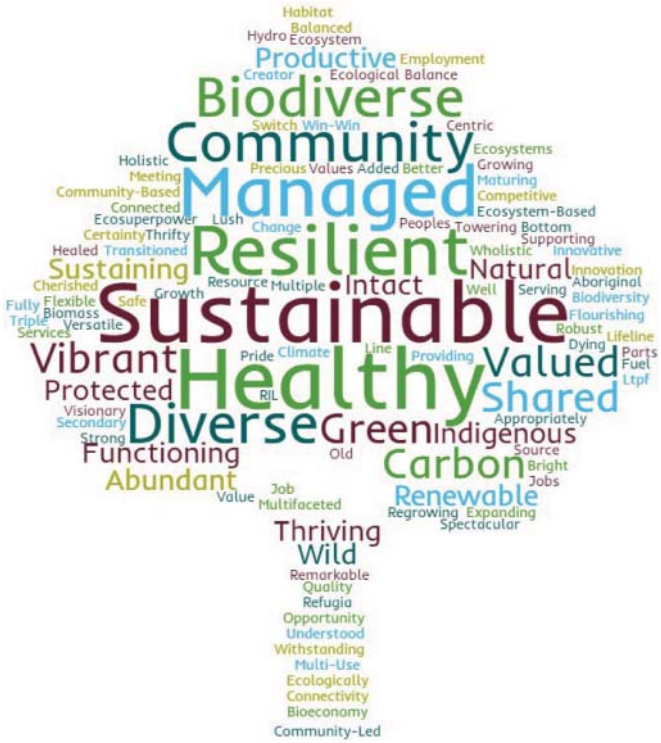
Old growth Douglas-fir at Cathedral Grove Provincial Park on Vancouver Island. Debate exists over the extent to which old growth forests in British Columbia should be protected from logging (Photo: John Innes).

On 27–28 February, 2020, a diverse group of people with a common interest in the future of the forests of British Columbia came together to discuss whether it would be possible to draft a vision for the future of British Columbia's forests and everything associated with them. An initial survey, focusing on key words, suggested that the potential was there, and the Summit confirmed that at a high level, and when taking a long-term perspective, there is

Cutblocks in the Adams Lake region of British Columbia. Concerns exist over the size of cutblocks, and the impacts on biodiversity and hydrology. (Photo: John Innes)

considerable agreement on what such a vision should look like. This is remarkable given that it is not long since "the war in woods", when environmental activists and forestry interests were openly fighting with each other over forest practices in British Columbia.

Prior to the meeting, participants were asked to identify three key words that described their vision for forests in British Columbia in 2070. The results are shown in the following diagram:



The size of the lettering in the diagram represents the level of agreement, with larger letting indicating that more people had used that particular keyword.

It is common to use a SWOT framework (Strengths, Weaknesses, Opportunities, Threats) when developing this sort of strategic plan. In developing the elements of the forests vision, participants were asked *not* to focus on weaknesses and threats (the usual result of applying the more familiar SWOT approach to strategic planning). Participants were also asked *not* to focus on how certain aspirations might be achieved. Instead the focus was on identifying whether there is common ground on the destination of choice. This was achieved using SOAR (Strengths, Opportunities, Aspirations, Results) methodology to identify broad goals that could be supported by tangible and measurable indicators of progress.

There was a broad level of agreement that we want healthy and resilient forests, and that this is the fundamental building block upon which everything else must be based. Damaged ecosystems need to be restored, including ensuring the recovery of species at risk. We need to retain wild areas and old-growth forests through conservation, and this is an area in which British Columbia could become globally renowned. It also ties into increased revenue streams in the form of ecotourism, recreation, and the conservation economy. Related to this, there is agreement that the forests of British Columbia represent a very significant opportunity to address carbon management and climate mitigation policies and objectives. Not only do B.C. forests represent a massive store of carbon, the landscape-scale CO2 removal potential of healthy and growing forests is unparalleled. This gives rise to the potential for carbon trading activity that could support financing many of the steps that will be necessary to achieve some of the goals identified during the Summit.

The importance of the forest industry to the economy of British Columbia was recognized by all. It provides revenues and jobs, and in the past was responsible for much of the Province's economic success. However, there is a desire to see a change in focus in management, away from one where timber dominates to one in which more values are taken into account. The Annual Allowable Cut in British Columbia needs to be based on the ecological capacity of the forests, with unsustainable cut levels being curtailed. Forest practices in British Columbia are good relative to some jurisdictions, but there is considerable room for improvement, particularly in the management of multiple values in the forest.

While the forest products industry in British Columbia has been experiencing significant problems, it was widely recognized that it is extremely good at what it does, namely the manufacture of dimensional lumber. At the same, time, the very high cost of logs in BC compared to other jurisdictions needs to be addressed if a viable forest products industry is to be achieved. Markets are changing, and this may cause problems

for manufacturers focused on a limited range of products and unwilling or unable to invest in new directions. The issues of waste and optimization came up many times: while it is accepted that tree harvesting will occur, there is a desire to ensure that the maximum possible value is extracted from any harvested tree.

The bioeconomy is presenting many opportunities, and in other parts of the world has become a reality. British Columbia has the potential to become a global leader in this area, but to do so, it will need to embrace innovation, new products, new markets and new business opportunities in the sector. The was some controversy around the extent to which 'value-added' products are already produced in British Columbia – this was caused by differing ideas on what constitutes a value-added product. The idea that British Columbia needs to diversify the range of forest products that is produced was repeated many times.

British Columbia has a huge potential advantage in its human resources. It has world-leading educational institutions, a highly skilled workforce and strong professional associations. It also has many informed and engaged individuals working in civil society who are passionate about forests and the forestry sector as a whole. This has in the past created conflict, but British Columbia has also seen the resolution of many conflicts in the forest, and has a history of finding solutions to contentious and divisive issues.

British Columbia is unusual in that most of its Indigenous population has never signed treaties with the governments of the day. With the Government of British Columbia having endorsed the UNDRIP (*Declaration on the Rights of Indigenous Peoples Act*) and the recommendations of the Truth and Reconciliation Commission, as well as enacting legislation to ensure that the principles of the UNDRIP are woven into provincial legislation and policy, First Nations have a critical role to play in the future of British Columbia's forests. It was evident that many participants recognized that in future, there will be greater First Nations' control of the landbase, including increased ownership, increased management rights and increased co-management. There is also a recognition of the need to see a greater proportion of the land managed according to the philosophy and principles of many First Nations, with greater attention being paid to holistic forms of management. The belief that First Nations' knowledge could be better used in the management of British Columbia's forests was stated repeatedly.

Governance and policy received relatively little attention. With the exception of suggestions for changes in the ownership structure of land and forests in relation to First Nations, the key concerns were related to ensuring that legislation and policy would not prevent a vision from being achieved, instead perpetuating the *status quo*. In addition, the need for cross-sectoral coordination, legislation and policy was identified, in particular to reduce the impacts of cumulative effects of development on British Columbia's forests and rangelands and to ensure that effective landscape-scale management can be undertaken.

Based on the ideas presented at the Summit, the Steering Committee agreed that the following vision and goals reflected the ideas and tone of the Summit:

Vision:

- *British Columbia has healthy and resilient forests that are the foundation for all forest-related activities.*

Goals:

- *Damaged ecosystems are restored, and species at risk have recovered.*
- *Wild areas and old-growth forests are retained through conservation, and British Columbia is recognized globally for this.*
- *The forest is managed for multiple values, and cut levels are determined on ecological principles*
- *First Nations are heavily involved in the management of forest lands, owning a significant portion of the forest estate and co-managing large parts of the remainder.*
- *British Columbia's forests are a massive store of carbon, and sequestration is enhancing this, and there is an active carbon trading market. As a result, the forests of British Columbia are making major contributions to the achievement of domestic and international carbon management and climate mitigation policies and objectives.*
- *Investment and revenue streams from ecotourism, recreation, carbon and the conservation economy are significantly enhanced.*
- *The forest products industry is a major employer, particularly in rural areas, and utilizes fibre obtained from forests in an optimal fashion.*
- *The forest products industry has secure, economically viable, timber supplies, is innovative and has diverse markets for its products.*
- *There is a diversity of manufacturing units producing a wide range of value-added products that satisfy the needs of the emerging bioeconomy, as well as more conventional products such as engineered wood products.*
- *Rural communities have become vibrant and dynamic.*
- *Supported by a range of world-class universities and training institutions, British Columbia is the foremost centre of expertise in conservation, forest management and advanced forest products processing, and has some of the best-trained and highly skilled forest-related people in the world. This expertise is sought all over the world.*

We are now engaged in the next steps, which involve ensuring that there is broad consensus on the vision, not only amongst participants in the Summit, but also amongst the many that were unable to attend. A series of Task Forces has been established to work out how the goals listed above might best be achieved, recognizing that several are contradictory to each other. The Task Forces are involving people from all aspects of forestry, from environmentalists to forest managers to wood products manufacturers, and their reports will be combined into a white paper that will be presented to the provincial government for further discussion.

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How our food choices cut into forests and put us closer to viruses

As the global population has doubled to 7.8 billion in about 50 years, industrial agriculture has increased the output from fields and farms to feed humanity. One of the negative outcomes of this transformation has been the extreme simplification of ecological systems, with complex multi-functional landscapes converted to vast swaths of monocultures.

From cattle farming to oil palm plantations, industrial agriculture remains the greatest driver of deforestation, particularly in the tropics. And as agricultural activities expand and intensify, ecosystems lose plants, wildlife and other biodiversity.

The permanent transformation of forested landscapes for commodity crops currently drives more than a quarter of all global deforestation. This includes soy, palm oil, beef cattle, coffee, cocoa, sugar and other key ingredients of our increasingly simplified and highly processed diets.

The erosion of the forest frontier has also increased our exposure to infectious diseases, such as Ebola, malaria and other zoonotic diseases. Spillover incidents would be far less prevalent without human encroachment into the forest.

We need to examine our global food system: Is it doing its job, or is it contributing to forest destruction and biodiversity loss – and putting human life at risk?

What are we eating?

The food most associated with biodiversity loss also tends to also be connected to unhealthy diets across the globe. Fifty years after the Green Revolution – the transition to intensive, high yielding food production reliant on a limited number of crop and livestock species – nearly 800 million people still go to bed hungry; one in three is malnourished; and up to two billion people suffer some sort of micronutrient deficiency and associated health impacts, such as stunting or wasting.

The environmental impacts of our agricultural systems are also severe. The agricultural sector is responsible for up to 30 per cent of greenhouse gas emissions, soil erosion, excessive water use, the loss of important pollinators and chemical pollution, among other impacts. It is pushing planetary boundaries even further.

A large soy field cuts into the forest in Brazil. (Photo: Shutterstock)

In short, modern agriculture is failing to sustain the people and the ecological resources on which they rely. The incidence of infectious diseases correlates with the current loss of biodiversity.

Deforestation and disease

Few viruses have generated more global response than the SARS-CoV-2 virus responsible for the current pandemic. Yet in the past 20 years, humanity has also faced SARS, MERS, H1N1, Chikungunya, Zika and numerous local outbreaks of Ebola. All of them are zoonotic diseases and at least one, Ebola, has been linked to deforestation.

Farming large numbers of genetically similar livestock along the forest frontier may provide a route for pathogens to mutate and become transmissible to humans. Forest loss and landscape change bring humans and wildlife into ever-increasing proximity, heightening the risk of an infectious disease spillover.

An estimated 70 per cent of the global forest estate is now within just one kilometre of a forest edge – a statistic that starkly illustrates the problem. We are destroying that critical buffer that forests provide.

Zoonoses may be more prevalent in simplified systems with lower levels of biodiversity. In contrast, more diverse communities lower the risk of spillover into human populations. This form of natural control is known as the "dilution effect" and illustrates why biodiversity is an important regulatory mechanism.

The pandemic is further heightening pressures on forests. Increased unemployment, poverty and food insecurity in urban areas is forcing internal migration, as people return to their rural homes, particularly in the tropics. This trend will no doubt increase demands on remaining forest resources for fuel wood, timber and further conversion for small-scale agriculture.

Wet markets under scrutiny

The links between zoonoses and wildlife has led to many calls during the current pandemic to ban the harvest and sale of wild meat and other forms of animal source foods. That might be too hasty a reaction: wild meat is an essential resource for millions of rural people, particularly in the absence of alternative animal food sources.

It is, however, not necessarily essential for urban dwellers who do have alternative sources of animal protein to purchase wild meat as a "luxury" item. Urban markets selling wild meat could increase the risk of zoonotic spillover but not all wet markets are the same. There are countless wet markets throughout the world that do not sell wildlife products and such markets are fundamental to the food security and nutrition as well as the livelihoods of hundreds of millions of people.

Even before the COVID-19 pandemic took hold, international agencies, including the Committee on World Food Security, have been concerned about the long-term viability of our current food system: could it provide diverse and nutritious diets while maintaining environmental sustainability and landscape diversity? The current pandemic has highlighted major shortfalls in our environmental stewardship.

We must harness the interconnected nature of our forests and food systems more effectively if we are to avoid future crises. Better integration of forests, agroforests (the incorporation of trees into agricultural systems) at the broader landscape scale, breaking down the institutional, economic, political and spatial separation of forestry and agriculture, can provide the key to a more sustainable, food secure and healthier future.

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From:theconversation.com

Vendors sell vegetables at a wet market in Bangkok, Thailand. (AP Photo/Gemunu Amarasinghe)

Selecting native tree species in Uganda for commercial use

The rich native flora of Uganda – Budongo Forest (Photo: Paul Jacovelli)

In the context of a master's degree in Forest and Nature Management at the University of Copenhagen, the authors of this article researched the topic of native tree species in Uganda and their economic value and related ecosystem services. For seven months, the authors gathered existing literature, contacted various stakeholders from the forestry sector in Uganda and analysed data to understand how native species could be assessed prior to an afforestation investment project. The research was focused on Uganda and the species investigated in depth were narrowed down to *Maesopsis eminii* and *Milicia excelsa* though a longer list of interesting species was found.

The purpose of this article is to give an overview of the importance of native species in afforestation projects but also the challenges one encounters when trying to investigate in such lesser known species.

Forest resources in Uganda

Deforestation in tropical countries often occurs in biodiversity hotspots, thereby endangering complex ecosystems, threatening the livelihood of local populations, and contributing to the current climate crisis.

With more than 18 000 species, Uganda is one of the most biodiverse countries proportionally to its size (Sulemanji, 2010). Though the country only constitutes 0.02% of the world's land area it is home to 11% of the world's bird species and 7% of the world's mammal species (Kayanja and Byarugaba, 2001). Forests are one of the major drivers of Uganda's biodiversity, supporting fauna and flora richness. However, the forests of Uganda have been degraded and the total forested area has declined tremendously. From 1990 to 2015 the total forest area declined from 4.9M ha. to 1.8M ha., corresponding to a decrease from 24% to 9% of the total land area (MWE, 2016). Not only does the forest degradation cause a loss of biodiversity but it also leads to soil erosion, carbon emissions and resource shortage. Deforestation also has a strong impact on rural communities which are dependent on wild plants and trees as a secondary source of income, often necessary for their livelihoods.

The deforestation leaves two major questions: How can the overexploitation of natural forested areas be stopped, and how can new forests and plantations be established in a sustainable way? A partial answer to the second question could be the integration of native species in commercial plantations to promote the conservation of these often-threatened native species but also decrease the pressure on natural forests from where they are harvested at present.

A focus on exotic species

To meet domestic wood demand, provide local forest owners with a stable source of revenue and combat forest resource depletion, the Ugandan forestry sector currently focuses its afforestation efforts on fast growing exotic species such as *Eucalyptus* spp., representing 43% the species found on the market in the country (MWE 2016). It is possible for exotic species to support biodiversity through regeneration of natural tropical forests and they can be used to nurse native species and accelerate colonisation processes on degraded land. Another advantage of exotic species is that their silvicultural characteristics and economic potential are well known and documented.

The role of native species

Native tree species present a wide range of advantages that are often thought to exceed those of exotic species, especially when looking at biodiversity value, for example, native flora and fauna

are co-dependent with native tree species which supports the dispersal and propagation of these species. In addition to their biodiversity value, many native species are multipurpose and provide a range of services to the local communities such as medicine, food or material for traditional constructions or art. Furthermore, some native species are also found to have a positive effect on soil nutrients and water.

Milicia excelsa is a good example of a native species providing a broad range of ecosystem services other than timber since the species is found to have medicinal properties, edible leaves, cultural value and also soil improvement qualities, making it a good agroforestry species.

Young Milicia excelsa tree (Photo: Erasmus Katusabe).

For these reasons interest in planting native species from local Ugandan organisations as well as international investors is growing. However, the silvicultural and economic potential of native tree species is often poorly documented which creates an obstacle for promoting native tree species in afforestation projects.

The challenges with native species

The main limitation encountered during this project was the lack of documented research conducted on native species. This included limited basic information on tree growth, silvicultural practices, costs and prices, all of which made it difficult to provide reliable estimates on profitability. Furthermore, the value of other ecosystem services provided by native species is often based on ethnobotanical research, the lack of which complicated the process of comparing ecosystem services between species and assessing their value.

Another limitation of assessing the potential of native tree species was the informal Ugandan market which is characterised by illegal logging, shifting prices and poor implementation of the existing regulations and monitoring systems. This creates a situation where it is difficult to determine the price of the wood and the potential demand.

Land rights and resulting disputes is another challenge when investing in afforestation projects in Uganda and more generally in Africa where 80% of the land is held under customary rights (USAID 2018). Industrial plantations in Uganda provide a range of benefits such as access to fuelwood and employment but they also deny historical customary land rights to local communities in certain cases, leading to potential conflicts and project failure.

Choosing selection criteria

Another over-arching challenge when choosing a species is the establishment of criteria for the decision. According to Evan and Turnbull (2004), a species selection decision should rely on the following questions:

1. What is the desired purpose of the plantation?
2. What is the availability of the species?
3. Will the species grow well on the sites available?

Due to the scarcity of silvicultural knowledge on lesser known native species, the following criteria can be included into the decision-making process:

- Is the species preferred by the local population?
- Is the species available in official seedbanks?
- What is the primary use of the species (i.e. construction wood, fuel wood, agroforestry, medicinal use etc.)?
- Is the wood workability good?
- Are there documentations of past experiences with the species in plantations?
- Are there available management recommendations in articles/ papers/ technical literature?
- What are the timber prices of the species on the Ugandan market?
- What are the management costs for the species?
- Does the species provide other important ecosystem services than timber?

This list is not exhaustive and can be adapted to different investment goals but it is important to underline that the choice of planting native species requires good preliminary assessment of the species in order to mitigate risks and avoid economic loss due to poor species knowledge.

The future of native species investments

Overall, the lack of resources invested in researching native species makes them a riskier choice than well known, exotic species such as eucalyptus or pine.

If these species are to stay in focus, systematic research must be promoted through supporting local researchers. Trials of potentially high-value native tree species must be established and monitored over rotations to document the growth and yield of these species and provide a decision basis for potential investors.

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REFERENCES
EVANS, J., and TURNBULL, J.W. 2004. Plantation forestry in the tropics: The role, silviculture, and use of planted forests for industrial, social, environmental, and agroforestry purposes. Oxford University Press.
KAYANJA, F., and BYARUGABA, D., 2001. Disappearing forests of Uganda: The way forward. Curr. Sci. 936–947.
MWE, 2016. State of Uganda's Forestry 2016. Ministry of Water and Environment, The Republic of Uganda, Kampala, Uganda.
SULEMANJI, M. 2010. A Contemporary Geography of Uganda, B. BakamaNume. ed. B. BakamaNume, Mkuki Na Nyota, Dar es Salaam.
USAID, 2018. 2018 Investor Survey on Land Rights. Perceptions and Practices of the Private Sector on Land and Resource Tenure Risks. U.S. Agency For International Development, Washington DC, USA.

Long term learning opportunities in temperate forestry

Royal Scottish Forestry Society – Monitor Woods Scheme (Learning by demonstration)

Bill Mason talking to RSFS members at Kilmun Forest Garden (Photo: Simon Stuart)

Concept and Vision

In 2016 the Royal Scottish Forestry Society (RSFS) approached the then Forestry Commission in Scotland (now Scottish Forestry) with a proposal for pump priming funding for a long term project aiming to enhance knowledge gathering and sharing in the Scottish forestry sector.

This was not a new concept as the RSFS North region had run a scheme called Demonstration woods in the 1990's which had five woods of different "types", each woodland to be visited on a five year rotation. The difference with the Monitor Woods Scheme (MWS) was the scale of the project with a target of over 100 woods to be involved.

The main idea for both schemes was that forestry in Scotland takes such a long time with even the fastest growing conifer species taking 40–50 years for final crop (this is coming down now to perhaps 35 years with improved Sitka spruce) and some broadleaved crops looking at 100's of years for one rotation. Government policy driving management policies may therefore change many times within the lifetime of the crop. Knowledge is also often lost between establishment and harvesting and in many cases is not disseminated fully or efficiently to many areas of the Forestry and Woodland sector. Some system of recording changes in management and in composition of woodlands over the long term would be a useful resource for many woodland management practitioners.

The vision for MWS is the efficient and widespread dissemination of knowledge. It is hoped that some of the groups which may benefit from the scheme and the planned open access online data management tool named Canopy would be;

1. Students studying Forestry or wider land management courses at college or university.
2. Early career foresters: With new recruits into the forestry industry often lacking any formal forestry and woodland management, practical examples of woodland management would be advantageous.
3. Established foresters: As careers develop, being able to take time out of a busy schedule to attend events and field days becomes more difficult. It may be helpful to have information available to enable judgement on how useful it would be taking time out to visit specific sites.
4. Researchers: Storage and dissemination of research material could be done more easily in a centralised system. Historical research would potentially be more easily accessed.
5. Visitors from overseas could use the resource to plan itineraries for group or personal visits to Scotland's woodlands. Having a record of past management as well as future plans would also assist in planning such visits

With all this in mind the MWS was set up with the following objectives.

i) Help forest managers improve the resilience, sustainability and profitability as well as wider outcomes from woodlands/forests by knowledge transfer, demonstration of problem solving and good practice, via an established network of practitioners prepared to share their experiences both good and bad.
ii) Overcome by practical demonstration and the dissemination of relevant information, the increasing isolation of practitioners and the lack of opportunity for learning in the field.
iii) Provide a living, expanding and increasingly valuable data set accessible for practitioners, students, researchers and the wider public.
iv) Broaden the constituency of interest in woodland management by encouraging those who wish to learn through access to demonstrations but who initially consider they lack adequate personal experience to enable them to confidently implement management practices that were suggested to be beneficial.
v) Make available to researchers a comprehensive monitoring, recording and knowledge transfer programme to ensure that longer term trial sites and the benefits thereof are not lost.

To begin with there was a lot of talk about demonstrating "best practise" and this is certainly one of the fundamental principles behind the scheme. However, it is also accepted that innovative and alternative management practises also are of interest as you never know what the best practise of the future might be. Another area for study is of course where things might not have gone according to plan, you often learn more from your mistakes and their correction than from everything going perfectly.

The scheme runs as follows:

- A candidate woodland (Principal Forest) is chosen.
- Within this forest several stopping points (demonstration plots) are identified which have specific areas of interest such as diverse species choice or silvicultural system for instance, these demonstration plots will form the basis of future visits.
- It is foreseen that RSFS regional groups will undertake to conduct the majority of visits to these sites on an appropriate rotation (probably at 5–10 year intervals). It is hoped that other groups visiting the sites would wish to share their information which could also be added to Canopy.

MWS Manager Simon Stuart (in HiVis vest) discussing the project in Cally Woods, Newton Stuart (Photo: Simon Stuart)

Progress so far

In late 2017 and early 2018 an initial cohort of 15 principal forests were surveyed and prepared for inclusion into Canopy.

In January 2019, a manager was appointed to take the project forward, helping to organise visits to existing Monitor Wood sites and to identify any further candidates for inclusion in the scheme. Another important role was to work with the software developer in the creation of the Canopy system. By the end of the year things were starting to come together and a plan was forming to double the Monitor woods within the scheme to 30 by the end of 2020 and to increase the number of sites visited by RSFS groups from 4 to at least 12. However, just as the visits were about to begin at the end of March a minor problem called Covid-19 appeared and scuppered everything, all site visits having to be cancelled. Work has continued over the summer to identify and prioritise the next batch of woodlands, which is especially important as the current list of potential candidates runs to over 160 woods.

The Future

The plan is to have Canopy fully accessible by the end of 2020 with at least 30 woodlands set up within it by March 2021.

If site visits are allowed, the target is to have at least 12 initial visit reports completed by the end of 2021.

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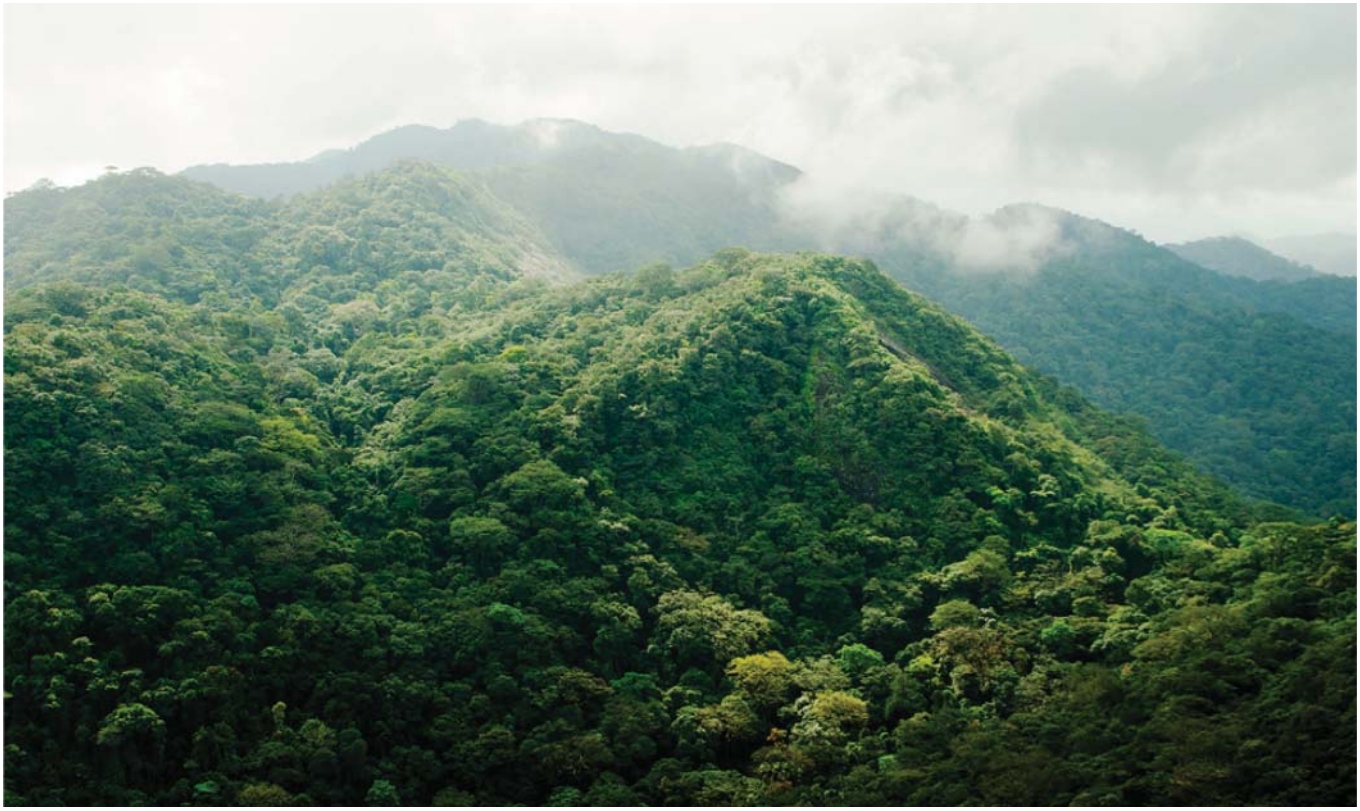
Sierra Leone's National Protected Area Authority and Conservation Trust Fund under focus



Sierra Leone's forests contain high levels of biodiversity

Background to Sierra Leone's natural resources endowment and conservation efforts

Small Sierra Leone with a land area of 27,000 square miles is historically a conservation oriented country, hosting a significantly rich biodiversity and stunning landscape, extending from attractive coastal beaches rising inland to Mount Bintumani – Sub-Saharan West Africa's highest mountain at 1945m.

Lying at the western edge of the Upper Guinea forest block, Sierra Leone's forests are designated as one of Conservation International's 34 global biodiversity hot spots. They are host to a significant population of west Africa chimpanzee populations, the very rare pygmy hippopotamus, plus an impressive variety of rare native and migratory birds.

Grouped amongst the poorest countries in the world, survival preferences in Sierra Leone understandably supersede natural resource conservation priorities in most rural areas. In addition, the 11-year-long rebel war exacerbated the abject poverty situation with over 70 % of the population recorded as being below the poverty level, and the 2010 UNEP assessment concluding that many of the pre-conflict situations in 2002 persisted by 2010.

Sierra Leone's National Protected Area Authority and Conservation Trust Fund was established in 2012 but only became fully functional in 2014 and is now poised to promote biodiversity, wildlife management, research and to provide for the sale of ecosystem services in National Protected Areas and support other conservation-related matters in Sierra Leone and beyond.

However, despite this potential forest conservation areas in Sierra Leone are limited. For instance, in 2011, there were only 48 forest reserves and other conservation areas nation-wide covering an area of 284, 591 hectares. Currently there are only two national parks: Outamba-Kilime National Park and the Gola Rain Forest National Park, established as a Peace Park in October 2011. There is also the small but biodiversity-rich Tiwai Island wildlife sanctuary established in the 1980s, lying between two chiefdoms, two districts and two provinces in eastern and southern Sierra Leone. In total, these protected areas cover only 4% of the country.

Both national and international conservation organizations have proposed additions to the existing network of protected areas and also the strengthening protection of the existing areas. The 2011 draft forest policy indicated an area of 36, 360 hectares would be added, increasing the area to about 12%. Also, the wildlife conservation Branch also proposed the inclusion of the Western Area Peninsular Forest Reserve and the Loma mountains to be upgraded to national parks status. The Gola Rain Forest Project will also eventually benefit from the Tropical Forest Conservation Trust-fund: a Royal Society for the Protection of Birds initiative.

Current major challenges affecting natural resouces management in protected areas

The following major challenges have overshadowed current gains in natural resources management in Sierra Leone:

- Wild-fires resulting for farm site clearance of unknown causes have now become an environmental problem in the country during the dry months of November to April. They are often responsible for vegetation transition from forests to secondary forests, and eventually farm-bushes after years of annual occurrence.
- Illegal chainsaw operations continue to impact pristine forests of high value timber leaving the degraded remnants unattractive to saw millers who pay actual stumpage, training and road maintenance fees.
- Shifting cultivation, which results in serious land degradation year-in year-out. The garbage burning encourages the loss of nutrients in the form of ashes and also through soil erosion. The very short fallow period of about 5 years on average does not encourage adequate site recovery in terms of nutrients recovery.
- Illicit mining in protected areas without site rehabilitation making site recovery virtually impossible.
- Use of fish poisons (herbal poisons and dynamites) in fishing, eliminating fingerlings that replenish the stock.
- Backfilling swamps for real estate development inducing flooding and the concomitant reduction of crop farming area.

The importance of local communities in protected area conservation and natural resources management

Local communities play crucial roles in natural resource management and conservation for the following reasons:

- They either reside in or live within close proximity to the resources to be managed. e.g. forests, rivers and streams, wetlands etc.
- They have a wealth of knowledge about the resources of which could be of crucial importance in its development.
- Their close proximity enables them to provide essential and timely information to save the forests, for instance from wild fires.
- They have vested interest in the resource and therefore act to protect it as stakeholders in order to ensure continuous benefits from the forests.
- They often offer a free service for resource protection because they have a stake in that resource.
- They are often land-owners and beneficiaries unlike forest or ordinary workers.
- When adequately incentivised they could be important partners in resource conservation and could be champions of conservation when they are willing, and their rights to the resources to be conserved are respected .

The NPAA and CTF making commendable progress in the country since 2014

Despite a few teething problems, the NPAA is making steady progress in collaboration with other conservation organizations nationwide. The current strategy entails the employment of social media to solicit the cooperation and support of the local resource-owning communities, civil society, community-based organizations, youth groups, local and international NGOs, Government and the donor community to push the natural resources development agenda forward in order to engender sustainable development of the country.

A 12-man board of directors sourced from the environment, conservation, agriculture, climate-focused and natural resources management sectors provide the professional ingredients required for sound resource management.

Significant efforts include support to parliamentary bills on natural resources management, advocacy for natural resources management, natural resources policy paper development and support towards tree planting initiatives.

Despite an understandably slow start, the NPAA continues to make progress in protected area and natural resources management, conservation, wildlife research and promoting payment for ecosystem services to provide funds for conservation.

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Join the XV World Forestry Congress in May 2021 in the Republic of Korea

Theme: Building a green, healthy and resilient future with forests

The World Forestry Congress is held every 6 years under the auspices of the Food and Agriculture Organization of the United Nations (FAO), and is the largest and most significant global gathering focused on forests and forestry. The Congress is open to all stakeholders, including governments, non-governmental and civil society organizations, private sector, academia, and other interested parties and individuals and serves as a platform to review and analyze current forest and land-use issues, and propose solutions for improved management and use of these resources.

The XV World Forestry Congress will be hosted by the Government of the Republic of Korea from 24 to 28 May 2021 in Seoul under the theme "Building a green, healthy and resilient future with forests". The theme reflects the integral role that forests play in ensuring the health, wellbeing and stability of the planet and its people. The theme is therefore timely and it will frame the discussions of the global forestry community to consider the state and future of world forestry, particularly in the context of the recovery from the COVID-19 pandemic, while at the same time striving to achieve the Sustainable Development Goals.

Six sub-theme sessions covering the most important current subjects concerning forests and the products and services they provide will form the basis of the main technical discussions of the Congress. The sub-themes are:

1. Turning the tide: reversing deforestation and forest degradation
2. Nature-based solutions for climate change adaptation and mitigation and biodiversity conservation
3. The green pathway to growth and sustainability
4. Forests and human health: revisiting the connections
5. Managing and communicating forest information and knowledge
6. Forests without boundaries: enhancing management and cooperation

The Congress will set the stage for a opportune discussion of how forests can help address and adapt to climate change, combat deforestation, conserve biodiversity and contribute solutions to other global environmental and sustainable development issues. At the same time, the coming global gathering will provide an opportunity to enhance cooperation and partnerships in forestry.

Registration for the XV World Forestry Congress Secretariat is currently open. Registrants will have access to all Congress sessions, official field visits and an innovative and educational exhibition.

All pertinent information on the Congress may be found on the official website http://wfc2021korea.org. The website is regularly updated with programme developments and logistical information. For further information on the programme contact WFC-2021@fao.org and for logistics info@wfc2021korea.org.

As the COVID-19 pandemic continues to sweep across the world, it is indeed imperative that the global community discusses the role that forests can play in creating a green and healthy future.

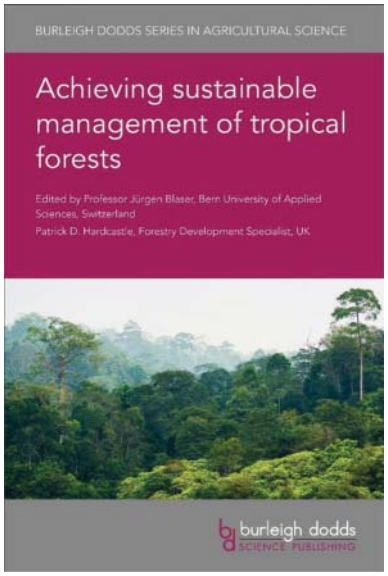
Simmone Rose
Programme Officer
XV World Forestry Congress Secretariat
FAO

Publications

Achieving sustainable management of tropical forests

Edited by: Jurgen Blaser and Patrick D. Hardcastle

Burleigh Dodds



Although global rates of deforestation have started to decrease, they remain alarmingly high in many tropical countries. In light of this challenge, the growing importance of sustainable forest management (SFM) has been highlighted as a means for improving sustainability across the sector.

Achieving sustainable management of tropical forests summarises and reviews the rich body of research on tropical forests and how this research can be utilised to make sustainable management of tropical forests a standard implementable strategy for the future. The book features expert discussions on the economic, political and environmental contexts needed for SFM to operate successfully, including coverage of the UN's Sustainable Development Goals (SDGs).

With its distinguished editors and international array of expert authors, *Achieving sustainable management of tropical forests* will be a standard reference for researchers in tropical forest science, international and national organisations responsible for protection and responsible stewardship of tropical forests, as well as the commercial sector harvesting and using tropical forest products.

Key features:

- Explores the broader economic, political and environmental context in which management of tropical forests needs to operate
- Particular focus on management structures and techniques to achieve sustainable forest management (SFM) on the ground
- Includes case studies of practical experience of managing tropical forests in South America, West Africa and Southeast Asia

Audience:
Researchers in tropical forest science; international and national government organisations and NGOs responsible for protection and responsible stewardship of tropical forests; commercial companies harvesting and using tropical forest products

Editors' details:
Dr Jurgen Blaser is Professor of International Forestry and Climate Change at Bern University of Applied Sciences, Switzerland. Professor Blaser is a former Chair of the International Tropical Timber Organisation (ITTO) and former Senior Forestry Advisor at the World Bank.

Pat Hardcastle is an internationally-respected Forestry Development Specialist with over 35 years' experience of forestry development and management. Pat has worked with organisations such as the ITTO, World Bank and the FAO.

Introduction to forest landscape restoration in Southeast Asia

RECOFTC

RECOFTC releases an easy-to-use guide to forest landscape restoration (FLR) to inform and support governments, civil society organisations and the private sector. The guide explains the fundamentals of FLR and serves as a starting point for future exploration and design of FLR initiatives.

Across Southeast Asia, deforestation and forest degradation continue at an alarming rate. This is having major, and often irreversible, impacts on ecosystems and people. Marginalized groups such as low-income, ethnic minorities and women are particularly affected because they depend on the forest and natural resources for survival. Deforestation and forest degradation also contribute to climate change, increasing forest communities' vulnerability to extreme events. Addressing these challenges grows ever more urgent.

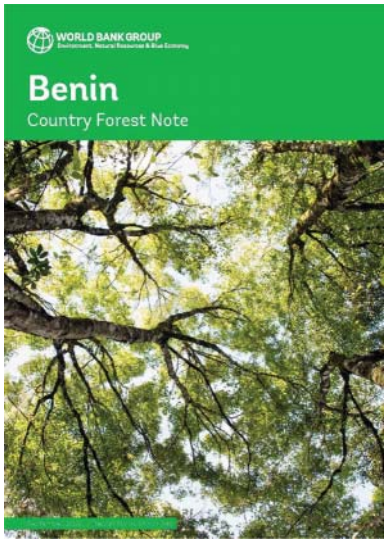
FLR places the livelihoods of groups that depend on forests at the centre of restoration interventions.

When local communities can find a way to benefit more sustainably from forests, they will grow and protect forests over the long term. FLR has immense potential to contribute to the fight against climate change, and it offers many other social, economic and environmental benefits.

Download the guide at https://www.recoftc.org/flr-guide-southeast-asia

Benin Forest Note

World Bank



The Republic of Benin has high forest cover that provide a full range of goods and ecosystem services. Beninese forests contribute to food security, provide timber, energy, climate risk prevention and job opportunities to thousands of communities. They also have a very high spiritual and religious value for local population. Benin is recognized for being a pioneer in participatory co-management approaches in West Africa. The national parks are essential for hosting key biodiversity in West Africa. Its savannah and mangrove forests store rich levels of soil organic carbon, contributing to climate regulation. However, the rapid deforestation and degradation levels over the past 10 years shows a significant pressure on this renewable natural resource.

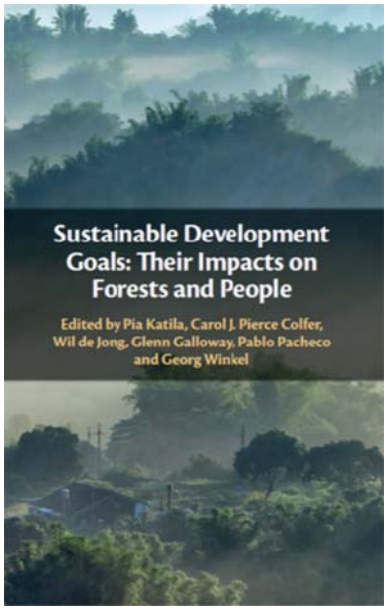
The Government of Benin recognizes the importance of investing in forest production and safeguarding its forests to support the national economy. It aims to increase investments in forest plantations to 15,000 ha per year and timber volume to 250,000 m^3 per year, while providing job opportunities and boosting its public revenues. It has recently updated its forest policy, forest code, and is improving its forestry tax system.

The Benin Forest Note presents forward-looking opportunities to strengthen the sector's contribution to the national economy, poverty reduction and sustainable development. Based on an integrated landscape approach, the Benin Forest Note assesses challenges and opportunities to improve forest use, restore degraded forests and maintain healthy forest cover. The Note shed light on opportunities to strengthen the national market and provide higher employment opportunities, contributing thus towards socio-economic and climate co-benefits.

Download the report at https://openknowledge.worldbank.org/handle/10986/34437?locale-attribute=en

Sustainable Development Goals: Their Impacts on Forests and People

Cambridge University Press



New comprehensive assessment of potential and anticipated impacts of efforts towards attaining the different SDGs on forests and forest-related livelihoods and development:

Forests provide vital ecosystem services crucial to human well-being and sustainable development, and have an important role to play in achieving the seventeen Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda. Little attention, however, has yet focused on how efforts to achieve the SDGs will impact forests and forest-related livelihoods, and how these impacts may, in turn, enhance or undermine the contributions of forests to climate and development. Understanding the potential impacts of SDGs on forests and forest-related livelihoods and development as well as the related trade-offs and synergies is crucial for the efforts undertaken to reach these goals. It is especially important for reducing potential negative impacts and to leverage opportunities to create synergies that will ultimately determine whether comprehensive progress towards the SDGs will be made.

This book discusses the conditions that influence how SDGs are implemented and prioritized, and provides a systematic, multidisciplinary global assessment of interlinkages among the SDGs and their targets, increasing understanding of potential synergies and unavoidable trade-offs between goals from the point of view of forests and people. Ideal for academic researchers, students and decision-makers interested in sustainable development in the context of forests, this book will provide invaluable knowledge for efforts undertaken to reach the SDGs.

The assessment was undertaken by the International Union of Forest Research Organizations' Special Project World Forests, Society and Environment (IUFRO WFSE). It involved 120 scientists and experts from 60 different universities and research and development institutions as well as 38 scientists who acted as peer reviewers of the different SDG chapters. The development and publication of the book and policy brief were made possible by the financial contributions of the Ministry for Foreign Affairs of Finland and the Natural Resources Institute Finland.

The book is published by Cambridge University Press and available as Open Access via Cambridge Core: https://www.cambridge.org/core/books/sustainable-development-goals-their-impacts-on-forests-and-people/5FA75743F80CCE33751BD2095E5754DC

The related ***Policy Brief Harnessing forests for the Sustainable Development Goals: Building synergies and mitigating trade-offs*** is available at https://www.iufro.org/fileadmin/material/science/spps/wfse/wfse-pol-brief-building-synergies-mitigating-tradeoffs.pdf

For more information about IUFRO WFSE visit: https://www.iufro.org/science/special/wfse/

Special Issue of Unasylva

Efforts to restore the world's degraded forests and landscapes must be scaled up to reach international targets by 2030, according to a new FAO publication released today.

The new edition of FAO's international forestry journal, Unasylva, entitled Restoring the Earth – the next decade, underlines that considerable progress in forest and landscape restoration has been made in the last ten years.

To date, 63 countries and other entities have committed to restoring 173 million hectares – an area half the size of India – and regional responses such as the African Forest Landscape Restoration Initiative (AFR100) and Initiative 20×20 in Latin America are making significant advances.

However, the publication warns that much more needs to be done at the national, regional and global scale to meet commitments under the Bonn Challenge, which aim to restore 350 million hectares of degraded and deforested lands by 2030, and other international pledges.

"Forest and landscape restoration is about much more than trees: it has social and economic benefits such as improving human well-being and livelihoods, and contributes to many of the Sustainable Development Goals, including mitigating climate change and conserving biodiversity," said Mette Wilkie, Director, FAO Forestry.

New initiatives

Launched today at the Global Landscapes Forum Biodiversity Digital Conference: One World – One Health, the latest edition of Unasylva outlines a series of new restoration initiatives and programmes that are increasing funding, empowering local stakeholders and enhancing technical assistance for forest and landscape restoration.

The publication also presents technical approaches, such as Assisted Natural Regeneration (ANR), to increase the adoption of forest and landscape restoration, and underlines the factors that underpin its implementation.

Among positive stories highlighted is China's success in reversing centuries of forest degradation and loss thanks to political leadership, multi-stakeholder involvement and an adaptive management approach.

Unasylva also profiles Northern Kenya's community conservation movement, which shows that land restoration is most successful when peace, governance, enterprise and wildlife conservation are also addressed.

Case studies in Brazil, Cambodia, Madagascar and Sao Tome and Principe meanwhile illustrate the range of options for institutional coordination mechanisms in forest and landscape restoration. Examples from the Niger and Burkina-Faso showcase the importance of local government and community's empowerment for planning and financing restoration and sustainable land management.

Action needed

The publication also outlines actions needed to realize the momentum offered by the upcoming UN Decade on Ecosystem Restoration (2021–2030) to upscale forest restoration across hundreds of millions of hectares.

These include developing comprehensive business cases for governments and private-sector investors, new policies and legislation to support investments in restoration, and protocols for restoration tailored for specific landscapes.

Effective monitoring at the global, landscape and project scales is also essential for keeping restoration on track.

"Societies worldwide will need to be convinced of the global restoration imperative by rational economic argument, compassion for current and future generations, and an emotional connection to nature," according to the authors of one article in the journal.

Related links

Unasylva: Restoring the Earth – the next decade Forest and Landscape Restoration Mechanism

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Around the World

Amazon: A new tool for tracking fires

In the southern Amazon, the dry season typically begins in July and continues through November, bringing increased fire activity along with it. Following a notable increase in fire activity in August 2019 and a gradual rise in deforestation across multiple years, a team of scientists at NASA and the University of California-Irvine has been watching closely for signs of how the 2020 season might shape up. Several worrisome signs have emerged.

In May and June 2020, warm Atlantic Ocean surface temperatures pointed to a greater risk of drought for key parts of the Amazon rainforest. Satellite-based deforestation tracking systems also have observed large patches of rainforest being razed in recent months, suggesting there is plenty of drying wood primed to burn. Finally, experts have warned that current economic conditions and incentives make land-clearing more likely.

But there is at least one piece of good news: NASA-funded researchers have developed new tools that will make it easier for governments and other stakeholders to understand what types of fires are burning, where they are burning, and how much risk those fires pose to the rainforest. The satellite-driven, web-based tool quickly classifies fires into one of four categories – deforestation, understory fires, small clearing and agricultural fires, and savanna/grassland fires. The tool was made available on the web on August 19, 2020.

The fire analysis tool is already bringing new clarity and insight to the 2020 fire season. In July, Brazil announced a 120-day ban on fires in the Amazon rainforest; it was presented as an effort to limit ecological damage from fires this year. However, the NASA-led fire analysis indicates that there has been a proliferation of fires in key deforestation hotspots in the southern Amazon states of Pará, Mato Grosso, and Amazonas.

"We see little evidence that the burning moratorium has had an impact. Instead, there is a noticeable increase in fire activity since the moratorium went into effect on July 15," said Douglas Morton, chief of the Biospheric Sciences Laboratory at NASA's Goddard Space Flight Center. "We are also finding that large numbers of the fires in those states are clearly deforestation – not small-scale agricultural fires."

Understory fires occur when other fire types escape their intended boundaries and burn through leaf litter and woody debris in standing Amazon rainforests. Such fires often have severe ecological impacts because Amazon forests are not adapted to fire. The risk of understory fires increases as the dry season progresses, especially during drought years. Savanna and grassland fires were also present along highways in this area, but these fires were especially numerous along the edges of the rainforest in eastern Pará and into the Cerrado region of eastern Brazil, where farmers routinely burn pastures to promote the regrowth of grass and savanna vegetation (which is adapted to frequent fires).

Small clearing and agricultural fires occur in forested areas but are short-lived and not linked to significant new deforestation. In 2020, satellites detected large numbers of these fires along the main stem of the Amazon River, likely caused by farmers burning small clearings or crop residue. (Note that fires with larger perimeters are depicted with larger circles. In general, deforestation and understory fires are significantly larger and longer-lived than the other two fire types.)

Niels Andela, a former NASA scientist who recently moved to Cardiff University, developed the algorithms for the Amazon fire classification tool. "Our analysis clusters active fire detections into individual fire events, and this allows us to track the size, behavior, and characteristics of each fire over time. Together, the fire behavior and land cover information provide a confident means to separate specific fire types," Andela said. "We can also identify what proportion of the active fire detections come from new fire starts, along with fires that have already been burning for two or more days."

This new approach provides unprecedented transparency about the number and type of individual fires burning across the Amazon region. The computer algorithm analyzes satellite imagery for characteristics of individual fires in order to separate them into the four types. Deforestation fires, for instance, typically have higher fire radiative power, a satellite-based measure of how much energy a fire releases. The algorithm also takes past deforestation activity into account before categorizing a fire, since the burning process can take several years to completely remove woody material from new pasture or cropland areas. Savanna fires, in contrast, burn less intensely and tend to spread quickly as they char grassy areas and pastures.

For each fire listed on the Amazon fire dashboard, scientists rank their confidence in the categorization of the fire as high, medium, or low. These rankings can change over time. For instance, it is initially challenging to distinguish between deforestation and understory fires, but it becomes easier over time because understory fires tend to spread farther and burn steadily over a long period, explained Andela.

The dashboard collects daytime and nighttime fire detections from the VIIRS sensors on the Suomi-NPP and NOAA-20 satellites. Land cover data comes from MODIS and Landsat. And data about the location of recent deforestation comes from Brazil's National Institute for Space Research (INPE), which draws on multiple satellites to identify such areas.

"We hope this tool pushes the conversation past some of the confusion surrounding the 2019 fire season," said Morton. "Satellites detect large numbers of fires in South America every year, but not all of these fires are of equal importance." The most problematic fires are deforestation and understory fires, which do the most lasting damage to intact rainforests. "By providing more information about fire types and locations in real time, we hope this dashboard will give decision-makers better information needed to manage and respond to fires."

The fire season in the Amazon generally intensifies in August and peaks in September and October. "It looks like we are headed into a situation comparable to 2019, or even worse," said Paulo Brando, a terrestrial ecologist at the University of California-Irvine, who helped develop the dashboard. "In addition to the area cleared in 2020, we have more than 4000 square kilometers (1,500 square miles) of cleared forests from 2019 that have not been burned yet. A big worry is that if a severe drought develops and make rainforests more flammable, we could soon see one of the worst environmental disasters in Amazonia during the 21st century."

earthobservatory.nasa.gov

Benin: The hidden value of Benin's forests

Benin's forests provide energy, food, medicine, places of worship and income that support the livelihoods of thousands of communities. They also regulate the air they breathe, the water they drink, and provide a home for animals. But between 2005 and 2015 Benin's forest cover dropped drastically by over 20% (from 7.6 to 6 million hectares) and deforestation rate continues to be very high at 2.2% annually. Rapid demographic growth, poor forest governance, slash-and burn agriculture, illegal logging and unsustainable wood cutting for energy and cooking have put the outstanding forests in jeopardy. Therefore, it's time to remind all the benefits of Benin's forest:

Their value on poverty reduction is underestimated. The World Bank's Forest Action Plan indicates that the impact of forests on poverty is felt the most in Africa. Forest-related income can lift 11% of rural households out of extreme poverty and forests can sustainably enhance food security. In Niger, farmer-managed forest regeneration on five hectares has doubled agricultural yields and could yield to the equivalent of US$500 million in nitrogen fertilization and 30 to 50 million tons of carbon sequestered. On a global scale, it is estimated that tropical forests can provide ecosystem services of up to $3,000 per hectare per year.

In Benin, forest ecosystems remain a hidden value. If well-managed and preserved, forests will boost economic growth, alleviate poverty and sustain a healthy living environment. The recently published Benin Forest Note sheds light on some of these values.

Forests generate tourism revenues. The heart of Beninese forests is found in the northern part of the country with the Pendjari National Park and the W National Park. Covering 1.26 million hectares, these parks harbor a unique biodiversity and key wildlife for West Africa. They are the basis for nature-based tourism industry, offering employment and earnings for communities. Since 2010, the Pendjari National Park has hosted about 6,500 tourists yearly.

Forests have a religious value. Benin has around 3,000 sacred forests which are protected with a first-of -its-kind legislation in Africa, providing legitimacy to traditional beliefs. Communities have high reverence for forests providing a forum for social, cultural and religious activities. They also offer vital medicines. For example, *kinkeliba* bush treat liver problems, *Cochlospermum planchonii* flowers help fertility in women and the sacred garlic pear is used as an antiseptic.

Forests produce timber and other high value products. Benin exports a significant amount of timber: in 2018, 102,000 m3 of Teak and Gmelina were exported. High valued products such as shea are the third largest export contributing 1.2% to the GDP while honey generates US$140,000 in revenue each year. Other products such as wild mushrooms, tamarind, African locust bean and baobab, among others, create income and job opportunities. Strengthening the value chains for these non-timber forest products would have a significant impact on the livelihoods of rural women and youth mainly involved in harvesting and processing activities.

Forests provide an important source of energy in Benin. With the inadequate energy supply, wood fuel and charcoal for cooking filled 46% of the country's energy demand in 2017. Fuelwood and charcoal production contribute 2.4% to the national economy but remain informal**.** The wood energy value chain employs 200,000 people with annual sales reaching nearly US$12 million.

Mangroves help combat coastal erosion. Benin's coast is exposed to the highest rate of coastal erosion in the Gulf of Guinea. The cost of coastal erosion in Benin was estimated at over $117 million in 2017, impacting the lives of thousands of communities. Mangroves provide one of the most effective solutions to address coastal erosion by controlling water levels and preventing soil erosion. As proven in other countries, coastal areas with extensive mangrove cover suffer less damage and loss of lives than areas without them.

The good news is that the Government of Benin recognizes the importance of investing in forest production and in safeguarding its forests to support the national economy. To strengthen the governance of the sector, it has recently updated its forest policy, forest code, and is now improving its forestry tax system.

The World Bank is also actively engaged in sustainably managing Benin's forest resources. The $ 60 million Benin Gazetted Forest Management Project aims to improve the sustainable management of forests in 13 state-owned forests. It promotes sustainable large-scale Acacia and Teak plantations to support both timber production and energy need. It also seeks to improve forest governance and promote non-timber forest value chains and markets in order to create jobs and improve livelihoods. In only a few months, the Project created 1,350 jobs in reforestation activities. Project beneficiaries received cash on a by-weekly basis through mobile transfer after verification of their performance. By end-December 2020, 3,200 jobs will be created for reforestation activities with a total transfer of USD 3.8 million injected to the local economy.

blogs.worldbank.org

USA: Large trees dominate carbon storage in forests

Large-diameter trees make up 3% of total stems, but account for 42% of total carbon storage in Pacific Northwest forest ecosystems

Older, large-diameter trees have been shown to store disproportionally massive amounts of carbon compared to smaller trees, highlighting their importance in mitigating climate change, according to a new study in *Frontiers in Forests and Global Change*. Researchers examined the aboveground carbon storage of large-diameter trees (>21 inches or >53.3 cm) on National Forest lands within Oregon and Washington. They found that despite only accounting for 3% of the total number of trees on the studied plots, large trees stored 42% of the total above-ground carbon within these forest ecosystems. This study is among the first of its kind to report how a proposed policy could affect carbon storage in forest ecosystems, potentially weakening protections for large-diameter trees and contributing to huge releases of carbon dioxide to the atmosphere in the face of a changing climate.

In the Pacific Northwest region of the US, a 21-inch diameter rule was enacted in 1994 to slow the loss of large, older trees in national forests. However, proposed amendments to this limit would potentially allow widespread harvesting of large trees up to 30 inches in diameter with major implications for carbon dynamics and forest ecology. Dr David Mildrexler, who led the study, highlights:

"Large trees represent a small proportion of trees in the forest, but they play an exceptionally important role in the entire forest community – the many unique functions they provide would take hundreds of years to replace."

To examine the relationship between tree diameter and aboveground carbon storage in forests east of the Cascades Crest, the researchers used species-specific equations to relate tree diameter and height to the aboveground biomass in the stem and branches, taking into account that half this biomass in a tree is comprised of carbon. They also examined what proportion large trees made up of the total forest stand, their total calculated aboveground carbon storage and therefore what the potential consequence of removing these large trees could have within future forest management practices.

The study also revealed that trees >30 inches (>76.2 cm) in diameter only constituted 0.6% of the total stems, but these giants accounted for over 16% of the total aboveground carbon across the forests examined. Once trees reached a large size, each additional increment in diameter resulted in a significant addition to the tree's total carbon stores:

"If you think of adding a ring of new growth to the circumference of a large tree and its branches every year, that ring adds

up to a lot more carbon than the ring of a small tree.' explains Dr Mildrexler. "This is why specifically letting large trees grow larger is so important for climate change because it maintains the carbon stores in the trees and accumulates more carbon out of the atmosphere at a very low cost."

The study highlights the importance of protecting existing large trees and strengthening the 21-inch rule so that additional carbon is accumulated as 21–30" diameter trees are allowed to continue to grow to their ecological potential, and letting a sufficient number of sub-21 inch trees grow further and become additional large, effective carbon stores.

Dr Mildrexler argues that this is among the most effective short-term options for stabilizing climate change and providing other valuable ecosystem services:

"Large trees are the cornerstones of diversity and resilience for the entire forest community. They support rich communities of plants, birds, mammals, insects, and micro-organisms, as well as act as giant water towers that tap into groundwater resources and cool our planet through evaporation."

"There is a real need for monitoring forest condition beyond what the forest service does on their inventory plots, and so local communities can also play their part to provide citizen science data and learn about the living forests on their lands, contributing to community income and mitigating climate change."

eurekalert.org

China's forest carbon uptake 'underestimated'

China's aggressive policy of planting trees is likely playing a significant role in tempering its climate impacts.

An international team has identified two areas in the country where the scale of carbon dioxide absorption by new forests has been underestimated. Taken together, these areas account for a little over 35% of China's entire land carbon "sink", the group says. The researchers' analysis, based on ground and satellite observations, is reported in Nature journal.

A carbon sink is any reservoir – such as peatlands, or forests – that absorbs more carbon than it releases, thereby lowering the concentration of CO2 in the atmosphere.

China is the world's biggest source of human-produced carbon dioxide, responsible for around 28% of global emissions. But it recently stated an intention to peak those emissions before 2030 and then to move to carbon neutrality by 2060. The specifics of how the country would reach these goals is not clear, but it inevitably has to include not only deep cuts in fossil fuel use but ways also to pull carbon out of the atmosphere.

"Achieving China's net-zero target by 2060, recently announced by the Chinese President Xi Jinping, will involve a massive change in energy production and also the growth of sustainable land carbon sinks," said co-author Prof Yi Liu at the Institute of Atmospheric Physics (IAP), Chinese Academy of Sciences, Beijing, China. "The afforestation activities described in [our Nature] paper will play a role in achieving that target," he told BBC News.

China's increasing leafiness has been evident for some time. Billions of trees have been planted in recent decades, to tackle desertification and soil loss, and to establish vibrant timber and paper industries. The new study refines estimates for how much CO2 all these extra trees could be taking up as they grow.

The latest analysis examined a host of data sources. These comprised forestry records, satellite remote-sensing measurements of vegetation greenness, soil water availability; and observations of CO2, again made from space but also from direct sampling of the air at ground level.

"China is one of the major global emitters of CO2 but how much is absorbed by its forests is very uncertain," said the IAP scientist Jing Wang, the report's lead author. "Working with CO2 data collected by the Chinese Meteorological Administration we have been able to locate and quantify how much CO2 is absorbed by Chinese forests."

The two previously under-appreciated carbon sink areas are centred on China's southwest, in Yunnan, Guizhou and Guangxi provinces; and its northeast, particularly Heilongjiang and Jilin provinces.

The land biosphere over southwest China, by far the largest single region of uptake, represents a sink of about -0.35 petagrams (billion tonnes) per year, representing 31.5% of the Chinese land carbon sink.

The land biosphere over northeast China, the researchers say, is seasonal, so it takes up carbon during the growing season but emits carbon otherwise. Its net annual balance is roughly -0.05 petagrams per year, representing about 4.5% of the Chinese land carbon sink. To put these numbers in context, the group adds, China was emitting 2.67 petagrams of carbon as a consequence of fossil fuel use in 2017.

Prof Paul Palmer, a co-author from Edinburgh University, UK, said the size of the forest sinks might surprise people but pointed to the very good agreement between space and in situ measurements as reason to have confidence in the analysis.

"Bold scientific statements must be supported by massive amounts of evidence and this is what we have done in this study," the NERC National Centre of Earth Observation scientist told BBC News. "We have collected together a range of ground-based and satellite data-driven evidence to form a consistent and robust narrative about the Chinese carbon cycle."

Prof Shaun Quegan from Sheffield University, UK, studies Earth's carbon balance but was not involved in this research. He said the extent of the northeast sink was not a surprise to him, but the southwest one was. But he cautioned that new forests' ability to draw down carbon declines with time as the growth rate declines and the systems move towards a more steady state.

"This paper clearly illustrates how multiple sources of evidence from space data can increase our confidence in carbon flux estimates based on sparse ground data," he said. "This augurs well for the use of the new generation of space sensors to aid nations' efforts to meet their commitments under the Paris Agreement."

Prof Quegan is the lead scientist on Europe's upcoming Biomass mission, a radar spacecraft that will essentially weigh

forests from orbit. It will be able to tell where exactly the carbon is being stored, be it in tree trunks, in the soil or somewhere else.

Another future satellite project of note in this context is the planned EU Sentinel mission (currently codenamed CO2M) to measure CO2 in the atmosphere at very high resolution.

Richard Black is director of the Energy and Climate Intelligence Unit (ECIU), a non-profit think-tank working on climate change and energy issues. He commented: "With China setting out its ambition for net zero, it's obviously crucial to know the size of the national carbon sink, so this is an important study.

"However, although the forest sink is bigger than thought, no-one should mistake this as constituting a 'free pass' way to reach net zero. For one thing, carbon absorption will be needed to compensate for ongoing emissions of all greenhouse gases, not just CO2; for another, the carbon balance of China's forests may be compromised by climate change impacts, as we're seeing now in places such as California, Australia and Russia."

bbc.co.uk

USA: VR helps visualise future of forests

Geographers in the US have created a virtual-reality (VR) forest, which simulates what various futures may hold under different climate-change scenarios.

The researchers at Penn State University combined information on forest composition with information on forest ecology to create a forest similar to those found in Wisconsin. In VR, people can walk through a simulated forest of today and see what various futures may hold for the trees in relation to the effects of climate change.

"The main problem that needs to be addressed is that climate change is abstract," said Alexander Klippel, a professor of geography at Penn State. "Its meaning only unfolds in 10, 15, or 100 years. It is very hard for people to understand and plan and make decisions."

The VR experience draws from extensive climate change models, sophisticated vegetation models, and ecological models, and all of these combined create a 2050 forest that people can experience by walking through it, investigating the tree types and understory, and seeing the changes.

The researchers first created a forest of today in which they used data from a typical Wisconsin forest. Here, the researchers could have used strict or deterministic rules and placed trees in the forest, but instead opted to use a procedural method that would populate the forest using a set of ecological rules, creating a more organic, natural feel.

"Orientation and small details of the trees are also randomised in the approach so that the trees don't look exactly the same," said Jiawei Huang, a graduate student in geography.

The researchers said: "Procedural rules allowed us to efficiently and reproducibly translate the parameters into a simulated forest." They used analytical modelling to convert the data for procedural modelling and also worked with ecological experts to provide feedback and evaluate the results.

To capture the ecology of the forest, the researchers used LANDIS II, a well-established, powerful model in the world of environmental research. They noted that the model is powerful enough to deal with events such as windstorms, fire, and flooding, as well as climate change.

According to the researchers, the virtual walk through of this Wisconsin forest shows tall trees and understory. Furthermore, strollers, using VR headsets and controllers, can reveal the types of trees in the forest, change elevations from forest floor to birds-eye view and in-between, and more closely examine the forest composition.

The researchers chose two future scenarios, a base scenario, and a hot and dry scenario. Using VR, visitors to the forest can see the changes in tree types and abundance and compare the base scenario to the hot and dry scenario.

"Our approach to creating visceral experiences of forests under climate change can facilitate communication among experts, policymakers, and the general public," the researchers report.

The team's aim is to also create a medium to communicate things in the future or the past that allows for a more holistic and visceral access so that non-experts can see the changes brought on by climate change.

eandt.theiet.org

Finland: Wood gains ground in electronics – rechargeable batteries become more ecological thanks to wood-based components

The global market of rechargeable batteries is predicted to increase tenfold in five years, especially because cars, bicycles and other vehicles powered by electricity are becoming more common.

Black liquor, a by-product of pulp production, has traditionally been converted directly into energy by burning. Higher-value uses are, however, constantly being looked for. One of them has been developed by Stora Enso as an alternative to the graphite used in producing rechargeable batteries. The raw material is special dry lignin, separated from black liquor.

The project by Stora Enso is an example of the forest industry's need to discover more valuable uses for black liquor, which is a source of lignin. 'At Sunila pulp mill, we have a long history of making use of lignin, now culminating in a unique pilot

plant,' say **Kari Nikunen**, director of the pilot plant at Stora Enso. The pilot plant aims at producing a completely bio-based, non-toxic and ultimately more effective alternative to the fossil graphite used in rechargeable and other batteries.

The annual lignin production capacity of Stora Enso's Sunila mill is 50,000 tonnes, making Stora Enso the world's largest producer of kraft lignin, a by-product of sulphate pulp production.

Making new products instead of simply generating energy

About half of the wood entering a pulp mill is actually turned into pulp, and the rest has traditionally been burned to generate heat and electricity. With increased energy efficiency, the forest industry has need to burn black liquor for energy. This has opened up opportunities for developing new products.

The goal is to find uses for black liquor that would be more profitable than using it for energy and benefit from the fact that it is derived from renewable raw materials.

The industrial use of lignin has been considered difficult, though it is already used to replace oil-based phenol adhesives in manufacturing plywood and laminated veneer lumber (LVL). In future, the production of lignin-based adhesives will increase, as will the manufacturing of coating agents, speciality chemicals and even carbon fibres.

Aiming at better batteries

The use of graphite in batteries is based on the fact that it is a good conductor of electricity. Traditionally, the cathode of lithium-ion batteries is made of lithium oxide and the anode of graphite more on how batteries function is found here).

'The graphite anode makes up about one fifth of the battery weight,' says **Lauri Lehtonen**, Head of Innovation (Biomaterials) at Stora Enso.

In itself, the alternative developed by Stora Enso is no lighter in weight than graphite. Further research on the material, however, aims at a battery that can be charged and discharged more rapidly and is more powerful. If this is achieved, fewer batteries are needed to store the same amount of electricity.

The raw material used for Stora Enso's product is extra dry lignin from the Sunila mill. 97 percent of its weight consists of dry matter.

In manufacturing the anode material, the oxygen contained by lignin is removed, causing a significant loss of weight in the material. If industrial-scale manufacturing of the material is started in Sunila, the current output of lignin will be enough to produce material for about 200,000 batteries for electric cars per year. According to Lehtonen, this would be a significant figure.

Results from pilot operation will determine fate of industrial-scale investment

The EUR 10-million investment in the pilot plant was made last year, and the plant will be completed in early 2021. Lehtonen says that this being a pilot-scale plant, its capacity is of little significance. The capacity will be enough for eventual customers to test the product properties.

'If we're successful with the pilot plant and it proves sensible to start industrial production, we can make the decision to invest. The results from operating the pilot plant will decide,' says Lehtonen.

Graphite is the most common form of carbon in nature. It is derived by mining, it is a fossil raw material and, in addition to rechargeable batteries, it is used most commonly in electric motors, as a lubricant, in nuclear reactors and in graphite pencils.

Natural graphite contains a great deal of impurities, such as metals, which must be removed. The removal processes require use of toxic acids.

The graphite currently used in rechargeable batteries is often synthetic, but that, too, is based on a fossil by-product of the oil industry. Its use requires comparatively complicated processes and it is also becoming scarcer.

Forest industry could tap an unprecedented potential

The global market of rechargeable batteries is predicted to increase tenfold in five years, especially because cars, bicycles and other vehicles powered by electricity are becoming more common. Rechargeable batteries are also needed by the expanding consumer electronics industry and large-scale energy storage systems.

The demand for lignin-based anode material has a higher growth potential than anything seen in the entire history of the forest industry. Stora Enso says that the growth in demand can also be satisfied by the use of lignin: after cellulose, it is the most common macromolecule in nature.

Lignin is found in all plants and has so far very few industrial uses. If made from black liquor, a by-product of pulp manufacturing, it will not directly increase the use of wood, which also increases the probability of there being enough of it to meet demand.

forest.fi

Global: Controlling deforestation and wildlife trade could prevent pandemics

Future pandemics could be prevented if unsustainable practices like deforestation and the industrial-scale wildlife trade are halted, according to a global biodiversity report. The cost of doing so would be paid back many times over, simply because we wouldn't have to go through another pandemic.

Millions of people are living or working in close contact with wild animals that carry diseases, and these industries aren't properly regulated. The more people cut down forests for farmland, for example, the more they are pushing into animals' habitats and thus coming into regular contact with disease-carrying wildlife.

Controlling the global wildlife trade and reducing land-use change would cost $40–58 billion per year, the report says. That is a lot, but the covid-19 pandemic is estimated to have cost the global economy $8–16 trillion by July. Before the covid-19 crisis, pandemics in total cost $1 trillion per year – including treatment costs and economic and productivity losses – including the ongoing HIV and influenza pandemics.

"It's a really incredible efficient economic return on investment we're going to see if we can do this right," says report author Peter Daszak at EcoHealth Alliance in New York.

The report was published by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

Almost every known pandemic disease came from an animal, says Daszak. Covid-19 came from bats in China. "HIV emerged from the hunting of chimpanzees," he says, and recent Ebola outbreaks stemmed from the hunting of wild primates.

Many of the most harmful practices are driven by consumption practices in the West. "The reason roads are being built in the rainforests of Indonesia is to supply palm oil," says Daszak. Palm oil is used in many food products, including packaged bread, ice cream and peanut butter.

Another issue is wild animals sold for pets and food, which are only tested for a handful of diseases. "The US is one of the biggest importers of wildlife," he says.

Studies of antibodies in people in China suggest that more than a million people every year are infected through bats with coronaviruses related to the one fuelling the current pandemic, says Daszak. The vast majority of these exposures don't cause major outbreaks, but each carries a risk.

"There's this huge population that's exposed at a gigantic scale across the region," he says. "It's people who live near bat caves, who shelter in bat caves to get out of the rain, who hunt and eat bats, who use bat faeces for medicine, who spread bat faeces on crops to fertilise them."

Live wildlife markets, like the one that was implicated in the early spread of covid-19, are also a factor if they aren't well run. Often multiple species are housed together in close quarters, and the stall owners live on site with their families. "There are many ways you could make that more secure," says Daszak.

The report will feed into the next major meeting of the Convention on Biological Diversity, which is taking place in China in 2021 after having been postponed due to the pandemic, says Anne Larigauderie, executive secretary of IPBES. The meeting will set global biodiversity goals for the next decade.

newscientist.com

UK: Chemical clues in leaves can reveal ash tree resistance to deadly disease

- Naturally occurring compounds in ash leaves could be linked to susceptibility or resistance of individual trees to the fungal disease ash dieback (ADB).
- Scientists at the University of Warwick and University of Exeter have identified a group of chemicals present in ash leaves which could be used as biomarkers to look for susceptibility or resistance to ADB.
- Identifying resistant trees and breeding from them could help populate the UK with ADB resistant ash.
- But, the same chemicals are used by trees to deter herbivorous insects, so selective breeding for ADB resistance could have the unintended consequence of leaving the UK ash population open to attack by invading pests.

Naturally occurring compounds in ash leaves could be linked to susceptibility of individual trees to the fungal disease ash dieback (ADB). But selecting trees with lower levels of these compounds and breeding for resistance could leave the UK ash tree population open to attack from invading insect pests in the future, according to scientists at the University of Warwick.

Secoiridoid glycosides are naturally occurring compounds found in plant leaves. Researchers from Warwick's School of Life Sciences and Department of Chemistry and the School of Biosciences at the University of Exeter looked at the abundance and diversity of secoiridoid glycosides in the leaves of a panel of ash trees known to be resistant and samples from trees known to be susceptible to ADB from both Denmark and the UK.

Previous research had identified five compounds in the secoiridoid glycoside family that were enriched in susceptible Danish trees, but results published today in Nature *Scientific Reports*, show UK ash tree leaves produced 27 different individually identifiable chemicals in the group. In the paper entitled *Diversity of secoiridoid glycosides in leaves of UK and Danish ash provide new insight for ash dieback management,* researchers have identified particular secoiridoid glycoside compounds that could potentially be used as biomarkers for tolerance or susceptibly to ADB.

Lead author, Dr John Sidda, from the School of Life Sciences at Warwick, said: "Ash dieback is an enormous problem for the UK, as ash makes up 5.5% of British woodlands. It is the third most abundant tree species in the UK with numbers exceeding 100 million trees. Ash dieback could be devastating to the British landscape and it is estimated it could cost the UK economy up to £15 billion. Currently there is no treatment for the disease so it is vital we understand all the possible pathways to developing resistance.

"Our work shows that the small molecules in leaves could give a pretty reliable indication of a tree's resistance as well as new insight into possible resistance mechanisms. Work is already underway to validate our results on a much larger panel of UK trees, and to identify other compounds that contribute to ash dieback resistance."

If potential ADB tolerant ash could be identified via a rapid test, they could be selected for breeding to begin repopulating the UK countryside. However, there may be another enemy on the horizon.

The Emerald Ash Borer (EAB) beetle is an insect pest of ash which has devastated the ash tree population in North America. The pest is moving towards Europe and has already been identified in Russia and Ukraine. At the current rate of spread it will reach central Europe in 15–20 years.

Dr Sidda said: "We know that secoiridoid glycosides play a number of roles in plants, and some of these compounds act as a defence mechanism against herbivorous insect pests. In selecting trees with lower levels of these compounds in order to help

protect the ash population against ADB, we may run the risk of reducing the UK's ash trees' natural defence against the EAB.

"However, our results indicate that there may be higher concentrations of secoiridoid glycosides in UK ash compared to Danish ash, so UK trees might be better protected against future herbivore threats such as EAB. There is also much more structural diversity of secoiridoid glycosides in the UK and Danish trees than we first thought.

"Researching and understanding these chemical compounds further will help us plan for protecting the UK ash population over the next few decades."

Professor Murray Grant, Elizabeth Creak Chair in Food Security at the University of Warwick and report co-author said: "These results are exciting as they reveal an unexpected diversity in this class of chemical compounds between ADB susceptible and tolerant UK trees, and also between Danish and UK ash. These may act as a potential reservoir of protective compounds that contribute to tree health.

"Our ongoing research is focussed on better understanding the biology of these compounds. We are grateful to funding from UKRI that allows us to expand this study to identify other chemical markers that discriminate tolerant and susceptible trees with the goal of developing a screen for ADB tolerant ash."

The project was funded by BBSRC.

warwick.ac.uk

Singapore embarks on a million-tree planting spree to protect its future

- *Between 1953 and 2018, Singapore lost nearly 90% of its mangroves to urban expansion and other human activities.*
- *Singapore has launched a new nature park that covers 400 hectares (990 acres), in an area that serves as a refueling site for migratory birds and a home to oriental hornbills, otters and crocodiles.*
- *The initiative is part of a larger effort to plant 1 million trees across the city-state by 2030.*
- *In addition to adding wildlife habitat, researchers say reforestation will help sequester carbon, lower the temperature of the city, and provide buffers against erosion and a rising sea.*

SINGAPORE – Languishing in the soft, silty mud, the living fossil looked as if it didn't have a care in the world as it feasted on the fish left stranded in the tidal mangrove pools of the Sungei Buloh wetlands. However, the saltwater crocodile (*Crocodylus porosus*) might have been a little less at ease if it knew nearly 90% of its mangrove habitat in Singapore has been lost over the past century.

But now Singapore is looking to reverse this loss by mounting an ambitious reforestation campaign. In August 2020, the Singapore government announced the launch of the new Sungei Buloh Park Network, a 400-hectare (990-acre) park in the northern portion of the island that is a refueling site for migratory birds and is home to oriental hornbills, otters, saltwater crocodiles, and many other species.

Sungei Buloh is part of a wider project that aims to plant 1 million trees over the next 10 years as the government tries to improve habitat quality for the city-state's wildlife while improving living conditions for its human residents.

Important habitat

Geography professor Dan Friess from the National University of Singapore has studied Singapore's mangroves for 11 years and heads up the university's Mangroves Lab, which focuses on the study of coastal wetlands in Southeast Asia. He says Singapore's mangroves have an outsize ecological impact.

"Singapore's mangroves punch way above their weight," Friess told Mongabay. "We only have a small area of mangroves, but within that we have huge biodiversity. For instance, in the U.S. they only have three species of mangrove plant species, while in Singapore you can find 35 different species of plant species in its mangroves."

Singapore's mangroves are relatively easy to access, providing a living laboratory for researchers who have uncovered many of their secrets through decades of study.

Helping ourselves by helping the forest

As a city-state with limited land resources, Singapore has long been torn between urban development and protecting nature. It lost much of its primary forest in the 19th century to logging, then a century later, a fast-growing population and rapid urban development meant that trees were removed for land reclamation and to build reservoirs for water security.

This expansion has taken a big toll on the region's mangroves. In 1953, Singapore's mangrove forests covered an estimated 63.4 square kilometers (24.5 square miles); by 2018, researchers estimate that number had been reduced to 8.1 km2 (3.1 mi2) – a loss of more than 87%. The country is now working to replace its losses by turning areas used for industry and infrastructure back into natural-looking landscapes. The National Parks Board (NParks) has already had some success with this, converting a brutalist stormwater canal that ran through a residential area into a natural grassy floodplain to cope with urban water runoff, and reestablishing the Sungei Api Api and Pulau Semakau mangroves.

Launched on March 4, 2020, the One Million Trees project involves restoration of both inland and mangrove forests. As of October, 51,819 trees have been planted. Four varieties of native coastal and black mangroves tree species have been selected by NParks to be used in reforestation efforts: *Palaquium obovatum*, *Buchanania arborescens, Fagraea auriculata* and *Sindora wallichii*. The latter two species are considered critically endangered in Singapore.

The trees are sourced from Singapore's tree banks, which include nurseries as well as trees that have been salvaged from construction sites. Up to 13,000 trees could be removed over the next 15 years to make way for transport and housing projects in Singapore, but the government has stated that for every tree it removes it will replant another. Trees from the tree bank are

destined for Singapore's parks, university grounds, rooftop gardens, roadsides and its outlying islands. They will also be used to help create 26 therapeutic gardens across the city for the aging Singaporean population. By the time One Million Trees officially wraps up in 2030, a goal is for all Singaporean households to be just a 10-minute walk from a park.

In the parks, city gardeners have been planting soil-boosting, nitrogen-fixing plants such as *petai* (*Parkia speciosa*) and great grasshopper tree (*Archidendron clypearia*), fruit-bearing trees such as the common sterculia (*Sterculia parviflora*) and the *kumpang* (*Horsfieldia irya*), and pollinator-attracting trees like *pulai penipu paya* (*Alstonia angustifolia*). They have also been helping to regenerate the rainforest by removing invasive weed species.

The government hopes greening the city will also help mitigate the "heat island" effect created by its pavement and skyscrapers, which absorb and radiate solar radiation and increase the temperature of Singapore's urban core. Researchers have found there can be up to a 7° Celsius (12.6° Fahrenheit) difference in temperature between Singapore's downtown and its less built-up portions.

Mangroves provide many ecosystem services to human communities. They can help stop soil erosion by holding it in with their roots, as well as reduce the impact of waves on the shore. And as mangroves can trap sediment between their roots and create their own soil, researchers say they may be able to help keep coastal cities like Singapore above water as the oceans rise due to global warming. (However, studies show mangroves may not be able to keep pace if greenhouse gas emissions accelerate and cause sea levels to rise too quickly.)

Trees play an important role in creating a livable environment, says NParks Conservation Group director Adrian Loo. "They serve as natural air filters, they reflect radiant heat and cool surfaces and [provide] ambient temperatures through shade and evapotranspiration; and help to mitigate the urban heat island effect and climate change," he said. "Healthy forests also play a role in regulating the water cycle, slowing down floodwaters and cleaning the water that flows into waterways."

The city also plans on more than doubling the amount of its "Nature Ways," which aim to make the streets cooler and more aesthetically pleasing while replicating some of the habitat value of forests by planting trees, shrubs and ground cover along sidewalks.

"The planting along these Nature Ways [is] not only designed to cool the environment (with a higher leaf area index), but also attract butterflies, garden birds and small mammals, bringing biodiversity and nature into our urban landscape," Loo said.

Carbon storage champions

There's another, not-so-local benefit to restoring mangroves: healing the global climate. Getting excess carbon out of the atmosphere through reforestation is a key strategy of multinational efforts to curb climate change. And research indicates that, pound for pound, mangroves can sequester far more carbon than rainforests do.

"Mangroves can store three to five times more carbon per hectare than other forest types can do," Friess said.

Just why are mangroves so good at carbon storage? Friess said it's because they are particularly effective at locking up carbon in soil.

"In a normal forest, leaves and branches would die, fall to the forest floor, and quickly get broken down by bacteria and fungi, which releases the carbon back into the atmosphere," Friess said. "Mangrove soils are waterlogged so they have a different microbial community, so organic matter is not broken down and the carbon stays locked up in the soils."

Friess and his colleagues found that even at their current reduced extent, Singapore's mangroves held 450,571 metric tons of carbon. However, this is not enough to compensate for the city-state's emissions. A report by the National Environment Agency states that the city-state released 48.6 million tons of CO2 in 2014, the last year for which data are available.

Professor Lian Pin Koh, a conservation scientist and director of the new Centre for Nature-based Climate Solutions at the National University of Singapore, says natural measures like reforestation are hugely important because they are immediately deployable.

"Nature had already done the research and development, the proof of concept and even the implementations at scale of carbon capture and storage," Koh said. "Manmade solutions are still many years and perhaps even decades away from becoming commercially viable and operational at scale."

When it comes to gauging the success of reforestation projects like One Million Trees, Jurgenne Primavera, former co-chair of the IUCN Mangrove Specialist Group, prefers to focus on science and ecology rather than targets or quotas. She said that problems with reforestation projects often arise when the wrong species are planted at the wrong sites. But she adds there are key signs when reforestation has been done effectively.

"High survival and growth rates and healthy forests of the correct trees species," Primavera told Mongabay. "For mangroves, for example, these would be *Avicennia marina* and *Sonneratia alba* along coastlines facing the open sea. For terrestrial species these would be native species and not exotics."

To safeguard the trees, NParks carries out regular inspections and offers best-practice workshops to organizations across the island. But Adrian Loo said that for the One Million Trees project to be considered effective, everyone needs to be involved: "The success of the project is also measured by our ability to instill a sense of stewardship among Singaporeans – towards our trees and environment."

mongabay.com