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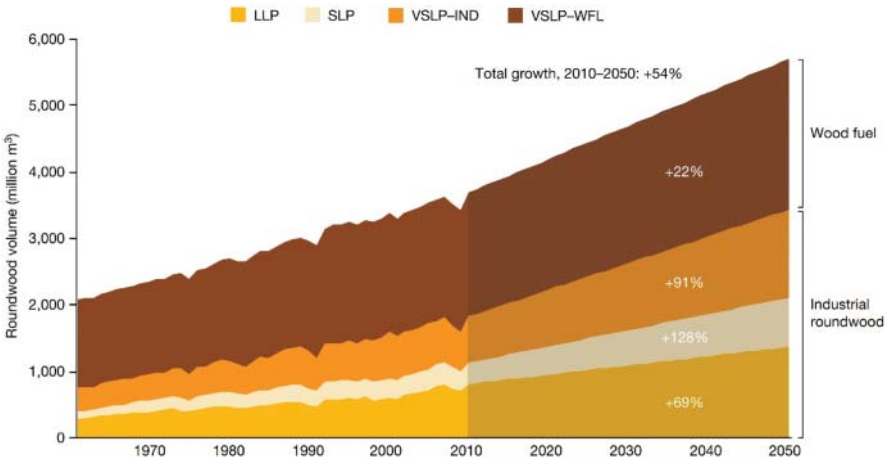
How will we meet the global wood demand?[1]



Historical and projected increases in global wood product production (million m³) between 1961 and 2050.[2]
(Source: Liqing Peng, Timothy D. Searchinger Jessica Zionts & Richard Waite (2023). The carbon costs of global wood harvests. Nature. https://doi.org/10.1038/s41586-023-06187-1)

In an age saturated with information—too much, too little, misinformation and misquoted information—reliable data remains the essential foundation for sound decision-making. Knowledge of global patterns of wood production and consumption are cornerstones for decisions on trade, investment, carbon, climate, biodiversity, and nearly everything else associated with forests.

There is a clear consensus and strong evidence that global demand for industrial roundwood (IRW) will increase substantially by 2050. While there is debate about the magnitude of this increase, numerous papers and presentations highlight the challenges of this expected expansion.

Forecasts for the increase in demand by 2050 vary significantly. A selection of prominent estimates includes:

- **Indufor (2012):** In a review for the FSC, its most realistic scenario suggested demand for roundwood would triple to just over 6 billion m³ by 2050, while a "stretch" scenario saw demand quadrupling to over 8 billion m³.
- **WWF (2013):** Suggested that global wood demand could triple by 2050.
- **ITTO (2014):** A study by Barua and Lehtonen suggested a 300% increase in demand by 2050.

[1] Contribution to the ACIAR-supported project "*Sustainable expansion of plantation forestry and wood processing in Laos and Australia*". VALTIP 4.

[2] LLP = sawn wood, wood panels and other industrial roundwood; SLP = refers to paper and paperboard products; VSLP-IND = refers to wastes of other wood product manufactured; VSLP-WFL = wood harvested to burn for energy.

- **Gresham House (2020):** Forecasted that global timber consumption will surge by 170% over the next 30 years.
- **Hetemäki *et al*. (2020):** A major publication from the European Forest Institute forecast a 16% increase in world roundwood production to 2050.
- **Held *et al*. (2021):** Suggested that global industrial roundwood production is projected to grow by 45% by 2050.
- **FAO (2022):** The data-rich *Global Forest Sector Outlook 2050* predicts that after reaching almost 2 billion m^3 in 2020 the further demand increase up to 2050 will be in the range of 27% to 44%.
- **Liqing Peng *et al*. (2023):** Their models predict that global wood harvests will increase by 54% between 2010 and 2050.
- **Nasi R (2025):** Projections suggest that global wood demand will increase from 4.1 billion m^3 in 2024, to 5.3 billion m^3 in 2030 to a 7.2 billion m^3 in 2050—a challenging increase of 75% over 25 years.

Caution should be exercised in interpreting and comparing the studies. There are nuances and they can measure different things:

- Global Demand for Wood
- Global Wood Production
- Industrial Roundwood Production
- Demand for forest products
- Annual harvests

The "Quadruple" Quote

Despite this wide range of projections, one of the most widely cited estimates is that "*global wood demand will quadruple by 2050*", a forecast consistently attributed to the World Bank. This statement appears to originate from the World Bank's Forest Action Plan FY16-20, which states, "

> *Demand for timber products is growing rapidly, with the demand for global industrial roundwood predicted to quadruple by 2050."*

Crucially, the plan attributes this prediction to the "stretch" scenario #3 from the Indufor (2012) paper.

Subsequently, numerous commercial intelligence publications, investment houses, and journals have explicitly attributed this "fourfold surge" to the World Bank. For example, a November 2022 report from Global Wood Markets was headlined, "*Global demand for timber could grow fourfold by 2050*," and stated;

> *"The World Bank forecasts that global timber demand will quadruple by 2050…".*

This "quadruple" quote has been cited and re-quoted, forming a foundation for national decision-making. It appears in 2023 report from the UK House of Commons, which quotes,

> *"The World Bank estimates that global timber demand is set to quadruple by 2050."*

The same assertion is repeated in Australia's 2021 Parliamentary Report, "*Market Dynamics in the Timber Industry*", attributed to the Australian Forest Products Association (AFPA). It was also repeated by PEFC's CEO in April 2023 and has been used by several regional governments and many others.

In November 2023, FSC used the following when encouraging participation;

> *"The global demand for forest-based products is anticipated to increase by a third by 2035, and quadruple by 2050."*

In Australia's most recent (2025) Timber Fibre Strategy, we again see the "fourfold" quote:

> *FAO forecasts that changes in the global use of wood products in modern methods of construction will be much more rapid with demand for mass timber products increasing at least fourfold from current levels by 2050.*

However, in this case, the estimate was limited to the increase in the use of mass timber products, a small proportion of the anticipated IRW demand of 2.5–2.8 billion m^3:

> *Assuming higher adaption of mass timber products in the construction sector, the additional primary processed timber demand could be between 41 million and 123 million m^3 RWE in 2050.*

In promoting the Victorian Government's investments to accelerate the growth of the state's forestry industry, Minister for Agriculture Ros Spence stated (Wood Central, Tue 19 Aug 25):

> *"Demand for timber is expected to quadruple globally over the next 50 years, and we're making sure Victoria has a secure supply," Minister Spence said. "Victoria is already home to the nation's largest plantation estate, and this funding will continue to strengthen our thriving and resilient timber industry."*

Clearly the "*quadruple*" quote has traction and is useful for promoting dialogue, but it should be interpreted carefully and can be contested.

The Role of Plantations and Policy Implications

With access to native forests diminishing, an expanded resource of planted trees will be vital for meeting future wood demands. Currently, plantations represent 7% of global forests but contribute 47% of the wood harvest; this share must increase to meet future demand. All the studies quoted above acknowledge that planted trees will be an integral part of future wood supply, a consistent message for over 30 years.

- **Wink Sutton (1992):** Argued that meeting global demand for industrial wood would require 110 million hectares of fast-growing species.
- **Indufor (2012):** Projected the global fast-growing plantation area will most likely almost double, expanding to 91 million ha by 2050.
- **FAO (2022):** Concluded that more than 33 million ha of additional, highly productive plantations are needed to supply the basic IRW demand expected in 2050.
- **Nasi (2025):** Potential sources for increased wood supply include an expansion of plantations of 120–150 million hectares.

- **Government of Victoria, Australia (2025).** Announced a $10 million investment to accelerate the growth of the state's forestry industry, supporting the establishment of new long-rotation timber plantations through the Victorian Plantation Support Program.

National decision-makers are now responding, but it is unclear which datasets they follow. Based on the persuasive assumption of rising global and regional wood demand, decision-makers in several Southeast Asian countries are developing national policies, creating new laws, and arranging land-use priorities and financing to foster plantation establishment. This is happening with the strong encouragement of donor partners and development banks like the Asian Development Bank and the World Bank.

In the region, experience has shown that planted trees grow very well, and the cultivation of fast-growing species has brought prosperity to many rural communities, where poverty alleviation remains a primary national development priority. For instance, colleagues in Lao PDR are making serious policy decisions regarding land use and plantations based on the assumption that wood demand will remain strong, committing millions of development dollars to the effort. Similar discussions are occurring in Cambodia and other nations in the region.

The consequences of getting these land-use assumptions wrong could be severe. There could be serious negative impacts on livelihoods, industry, and national economies if this assumption of strong growth proves false.

The Need for Reliable Data

The forecasts for future demand are based on the assumption that the area and productivity of existing plantations will be maintained. If productivity declines, more land—the ultimate finite resource—will be needed.

So how big is the expected demand, and how reliable are the scenarios? The vast level of variation suggests that careful examination is required. As Kallio and Solberg (2018) noted, statistics on forest products contain remarkable inconsistencies, sometimes of the magnitude of millions of cubic meters. They warn that errors of this size have important consequences for any analysis and "call for special attention by the data users."

Even taking the most conservative scenarios into account, the scale of the required increase is immense. Using FAO's 2024 baseline IRW consumption of 2.2 billion m³/year and their modest 27% to 44% growth forecast, the world would need an additional annual harvest of 600–1,000 million m³ over the next 25 years.

An increase of even the lower-end estimate (600 million m³) is equivalent to:

- 1.5 times the current production from the USA
- 7 times the current Swedish harvest
- 8 times the current German harvest
- 10 times the current Finnish harvest
- 23 times the current harvest in British Columbia
- 24 times the current Australian harvest

Can this be achieved? Given the enormous economic and environmental decisions being made, is it time to establish a new, more reliable series of datasets upon which to base policy?

A Final Observation.

In the process of assembling this note and reviewing a great deal of literature, I have not found a single published projection that concludes the world will need LESS industrial roundwood in 2050 or beyond. Well-planned and well managed plantation investments are highly likely to succeed.

Leading to some Basic Questions.

If we accept the that global wood demand will increase substantially to 2050:

Where will the additional wood come from?

Acknowledging that supply from native forests will be constrained because of needs for biodiversity, conservation, carbon, changing political perceptions and acknowledging that trees might not be an attractive option for landowners and smallholder farmers (competition from agriculture):

Where are the hectares to produce this additional wood?

Acknowledging that land availability is a constraint, current hectares producing wood must be carefully nurtured to produce and sustain more wood production.

Can we maintain (increase) productivity—produce more wood from the same number of hectares?

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Essay

CFA Voices: Trembling trees, fleeing fauna: the climate crisis in Pakistan's green heart

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The Islamic Republic of Pakistan, an independent sovereign state since 1947, lies between latitudes 23°35′ to 37°05′ North and longitudes 60°50′ to 77°50′ East. It stretches from the Arabian Sea in the south to the towering Hindukush Mountains in the north, sharing borders with Iran, Afghanistan, China, and India.

Pakistan is a forest-poor country, with forest cover accounting for only 4.8% of its total land area—approximately 4.22 million hectares. Of this, around 1.91 million hectares comprise coniferous forests. Among the country's diverse forest ecosystems, moist temperate forests, located between 1500 and 3000 meters elevation in the Western Himalayas, are ecologically vital. These forests thrive where annual rainfall exceeds 1000 mm and are typically divided into lower and upper zones. Dominant conifer species include *Cedrus deodara*, *Pinus wallichiana*, *Picea smithiana*, and *Abies pindrow*, while oak species such as *Quercus incana*, *Quercus dilatata*, and *Quercus semecarpifolia* also contribute significantly to forest composition.

Environmental importance of moist temperate forests

Moist temperate forests play a crucial role in maintaining ecological and climatic stability. They influence local and regional climate systems by regulating surface temperatures, humidity, cloud formation, and precipitation. These forests also provide essential ecosystem services such as carbon sequestration, water regulation, erosion control, and buffering against temperature extremes.

However, the integrity of these ecosystems is increasingly threatened by climate change. Rising temperatures, changing precipitation patterns, more frequent extreme weather events, and surges in pest and disease outbreaks are placing immense stress on forest health and resilience.

Impact of climate change on forest structure and productivity

Globally, climate change is driving forest ecosystems to shift toward higher altitudes and latitudes. In Pakistan, this shift could result in the upward migration of moist temperate forests, altering their species composition and productivity. While elevated carbon dioxide levels and longer growing seasons may initially enhance forest growth, these benefits are offset by reduced frost tolerance, increased vulnerability to pests and pathogens, and a decline in overall forest stability.

Climatic variations also disrupt phonological events such as bud break and flowering, which diminishes forests' carbon storage capacity and ecological function. Moreover, limited national data on forest health and productivity constrains the development of effective climate adaptation strategies.

Impact of climate change on wildlife and their habitats

The moist temperate forests of Pakistan provide critical habitats for a diverse array of wildlife, including endangered and

Ayubia National Park situated in the moist temperate forest region in Pakistan

endemic species such as the Western Horned Tragopan Pheasant, Himalayan Monal Pheasant, Kashmir Markhor, Himalayan Musk Deer, Asiatic Black Bear, and Indian Leopard. These species are intricately adapted to the specific microclimates and vegetative structures of this region.

Climate change is disrupting these habitats in multiple ways:

Habitat fragmentation and range shifts
Rising temperatures are pushing species to migrate toward higher, cooler altitudes. However, suitable habitats in these zones are often limited, leading to increased competition and shrinking species ranges. Environmentalists have noted that wild boar, previously confined to tropical plains, began appearing in hilly temperate regions after 2013. This shift is believed to be a direct response to rising temperatures in the mountainous zones.

Altered food availability and phenology
Climate-induced changes in flowering and fruiting cycles affect food availability for herbivores and their predators. This disrupts feeding patterns, breeding success, and the broader ecological balance.

Increased human-wildlife conflicts
As wildlife ventures closer to human settlements in search of food or habitat, conflict escalates. A study conducted in 2019 at Ayubia National Park, situated in the moist temperate zone, confirmed growing conflict due to wild boar incursions. These animals, driven by climate shifts, inflicted an estimated economic loss of approximately USD 11,625/per annum on the local community. In addition to damaging crops, wild boars are known for degrading natural vegetation and transmitting diseases harmful to native wildlife.

Disease spread and physiological stress
Changing temperature and humidity levels can facilitate the spread of vector-borne diseases and increase physiological stress among wildlife species, weakening immune responses and reducing survival rates.

Loss of specialized niches
Highly specialized species, such as cavity-nesting birds or altitude-dependent mammals face heightened extinction risks as their narrow habitat ranges disappear or degrade due to climatic shifts.

The way forward
Addressing these challenges requires the integration of climate adaptation strategies into forest and wildlife management plans. This includes improving ecological monitoring, restoring degraded habitats, enhancing connectivity between forest patches, and increasing community awareness and involvement. Investment in research and adaptive management practices is essential to maintain both forest health and biodiversity under a changing climate in Pakistan.

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Camera-Trap record of wild boar in Ayubia National Park

Forest Scenes

Carbon Offsets Are Failing. Can a New Plan Save the Rainforests?

Brazil is set to unveil an ambitious international plan that would provide up to $4 billion a year to countries that protect their tropical forests. Proponents see it as a potential game-changer for forest conservation, but some ecologists and economists are raising concerns.

It could be the last and best chance to save the world's tropical forests. As international aid budgets for conservation crash and carbon offset schemes for protecting forests are widely discredited, Brazil is about to unveil an ambitious plan that would triple current finance for saving forests worldwide by channeling profits from international trade in government bonds.

The Tropical Forest Forever Facility (TFFF) is set to be announced by President Luiz Inácio Lula da Silva as a centerpiece of the U.N. climate conference in the Amazon city of Belém next month (Dec 2025). It would create a $125 billion investment fund intended to provide up to $4 billion a year to potentially 74 tropical and subtropical nations as a reward for protecting their forests.

The viability of the proposed scheme is being questioned by some ecologists and economists. And rich-world governments and philanthropic organizations have so far been slow to follow Brazil in pledging the seed funding thought necessary to attract private investors. But late last month the World Bank agreed to become the facility's trustee and interim host, raising hopes ahead of the TFFF's launch.

The TFFF's backers see the fund as a potential jewel in the crown of green capitalism, with bond markets coming to the rescue of the rainforests. Brazilian environment minister Marina Silva told a London Climate Week audience in June: "It will mobilize large-scale capital with sustained financial flows to conserve our biodiversity." For Zac Goldsmith, British senior fellow at the Bezos Earth Fund, a potential funder, "the TFFF is the only game in town for forest finance… We will not have this opportunity again."

The World Bank will now become the administrative headquarters of the facility, as well as eventually overseeing transference of its anticipated profits to tropical countries. "With this foundation in place, the TFFF is now ready for countries to follow Brazil's lead by making their own pledges," said Brazil's finance minister Fernando Haddad.

But there are concerns. Forest ecologists warn that the plan's rulebook is so loose that it could allow payouts for forests even as they are being logged. Rights activists warn that Indigenous peoples could lose control of their forests. Meanwhile, some economists argue that the project's proposed financial architecture is both risky and inherently unfair. Much of the money for forest protection would come from the high interest rates charged on volatile loans to the very countries whose forests it promises to benefit. Without those hefty payments, says Max Alexander Matthey of the University of Witten/Herdecke in Germany, "there is no money for the forests."

The Atlantic Rainforest in southern Brazil. (Credit: OCTAVIO CAMPOS SALLES)

A logger illegally cuts down a tree in Rondônia state in the Brazilian Amazon. (Credit: LYNSEY ADDARIO / GETTY IMAGES)

Under the TFFF, countries would be paid initially according to satellite measurements of the extent of their standing tropical and subtropical moist broadleaf forests, at an annual rate of $1.60 per acre. In subsequent years, every acre deforested would result in a reduction in payments equivalent to at least 100 acres. Countries with an annual deforestation rate above 0.5 percent—which currently includes major forested nations such as Indonesia and the Democratic Republic of the Congo—would be barred from receiving any funds.

It could potentially be a "game-changer" for forest conservation, says Robert Nasi, director general of the Indonesia-based Center for International Forestry Research. If successful, it "could become a blueprint for other… critical ecosystems like peatlands and mangroves," he says.

Nobody doubts the need for new impetus to save tropical forests from continued invasions by farmers, loggers, and miners and the spread of wildfires. Last month, a new assessment found an upsurge in deforestation rates in the tropics, reaching a record 16.5 million acres last year and leaving the world far off track to meet the promise of governments to end deforestation this decade. (The only good news was from the Brazilian Amazon where a sharp decline achieved the lowest rate of forest loss since 2015.)

Meanwhile, foreign aid budgets that have funded much forest conservation in recent years are in freefall, both in the United States and Europe. And market-based systems of forest protection and restoration based on trading in carbon offsets are floundering. A global analysis published in October found that less than a fifth of such projects met their emissions targets.

So, for governments and forests alike, the investment-led TFFF—with just a fifth of the fund intended to come from governments and philanthropic sponsors, and the remainder from private investors—seems like a lifeline.

It has strong backing from major environmental groups such as the WWF and Conservation International. But there are concerns among forest ecologists that the small print defining what counts as standing forest worthy of rewarding could create perverse incentives for further destruction.

Most intact moist tropical forests have canopy cover greater than 80 percent. Much less usually indicates they are badly degraded, for instance by loggers, says environmental scientist Brendan Mackey of Griffith University in Queensland, Australia. Yet the TFFF's criteria for full payment currently require only 20 percent cover. "This is not scientifically credible" he says.

An oil palm plantation on the site of former rainforest in the Democratic Republic of the Congo. (Credit: DANIEL BELTRÁ / GREENPEACE)

The most recent Brazilian briefing on the project argues that this loose definition recognizes the value of all standing tropical forests, "not only those classified as intact, high integrity, or primary." Mackey agrees that such degraded forests are worth protecting and restoring, but believes that there should be a premium for forests with "high ecosystem integrity." Otherwise, as presently drafted, says Kate Dooley, an expert on forest governance at the University of Melbourne, the TFFF "would allow payments even where industrial logging is occurring in primary forests."

The fund's rulebook does impose some penalties for forest degradation, but only in the case of forest fires, which it describes as a "proxy" for wider disturbance. This is a mistake,

says Dooley. "A fire in a moist tropical forest is an indication that the forest has already been severely degraded for some time." Satellites, aided by A.I. analysis, can now identify other forms of forest degradation, such as logging, roads, and mining with increasing accuracy, says Bill Laurance, an environmental scientist at James Cook University in Australia. So, critics say, the definition of degradation warranting penalties should be extended.

There is a similar debate among forest Indigenous peoples and NGOs that represent them. After lobbying from rights groups, the TFFF rulebook now stipulates that while the funds it disperses will go initially to national governments, at least a fifth of the money should ultimately be devoted, directly or indirectly, to Indigenous and forest communities, who are the custodians of the majority of the world's intact rainforests.

Many cheer this latter requirement. The Global Alliance of Territorial Communities, which represents 35 million forest people in 24 countries, sees it as "a key political opportunity… to ensure fairer and more direct access to climate finance."

"For all its flaws," says Matthew Owen, director of Cool Earth, a U.K.-based NGO that supports Indigenous community conservation work, "TFFF signals that forest protection is finally being treated as a global public good worthy of ambitious financial commitment. It is the best chance we have to fund a halt to tropical deforestation."

But other activists for Indigenous communities are wary. The Global Forest Coalition, which has more than a hundred affiliated groups in 71 countries, fears that governments will not hand over money directly, but will instead give it to government agencies and private companies working with Indigenous people. And it contends the incentives for wider forest protection could become a pretext for criminalizing traditional forest uses such as shifting cultivation.

Faced with such concerns, many forest activists want to help improve the rulebook and hope that flaws can be fixed. They have already achieved agreement on a ban on investments by TFFF in fossil fuels, mandatory payouts directed to the interests of Indigenous peoples, and a scientific advisory panel to refine monitoring and reporting on the state of funded forests, says Tyala Ifwanga of the European forest-policy NGO Fern. "It is far from ideal, but we are trying to make sure it can be as effective as possible."

A new version of the plan is due for release next month in Belém. Mackey is among the critics of TFFF who are optimistic. "I remain supportive of the Brazil government's efforts and look forward to working with them to help with strengthening the next iteration," he says.

One big concern that may be hard to resolve, however, is the financial architecture devised to deliver revenue for investors, sponsoring governments, and the rainforest alike. It is, critics say, both inherently risky and designed to benefit investors first, rather than forests and the countries that host them.

The fund is likely to work like this. Money put into the fund by private investors, such as bankers and hedge fund managers, will mostly buy assets in developing countries that pay high interest rates. These will include fixed-interest sovereign bonds sold by governments that typically yield a return of around 8 percent. But the private investors will only be paid a return of around 5 percent. The 3 percent difference—amounting to around $4 billion per year, if the project is fully funded—would be enough to pay for conservation of 2.5 billion acres of forest, roughly equivalent to all the world's natural tropical rainforests.

An obvious question, notes economist Matthey, is why the investors don't buy those bonds themselves and pocket the extra cash. The answer is that the high-interest bonds are regarded by traders as risky, with a high chance of the borrowers defaulting. That is why developing countries have to offer the higher rate to entice lenders. That makes the 3 percent "leftovers" intended for forests a "risk premium, compensating for the danger of holding volatile assets," says Matthey.

Far from being the stable source of funding claimed by its promoters, he says, forest funding from the TFFF could easily unravel if economic conditions change. Nasi agrees: "A major market crash… could decimate the investment fund's value, forcing a prolonged suspension of payments and threatening the entire model."

TFFF's architects dismiss such fears. They acknowledge there could be "market fluctuations," during which forest payments would be the first to lose out. But catch-up payments could be made later. "Over the long run, the risk is minimal," according to João Paulo de Resende, a senior official at Brazil's Ministry of Finance.

But even if the funding model proves financially sustainable, some critics argue that it is exploiting an unethical financial system to the detriment of developing countries. "It is developing countries' onerous debt servicing that is paying for this scheme," says Chien Yen Goh, a legal advisor to the Malaysia-based nonprofit Third World Network. They are being required to "underwrite forest protection that benefits the entire planet."

Satellite images show where the Amazon rainforest has been destroyed (left to right) by mining, farming, and fire. (Credit: NASA)

Indigenous Tbit men guard their forest in Southwest Papua, Indonesia. (Credit: JURNASYANTO SUKARNO / GREENPEACE)

Whatever its potential drawbacks, backers say the TFFF could transform the finance available for protecting the world's tropical rainforests. So, will it get the funding that the Brazilians are asking for?

The first requirement is for national governments to put up the $25 billion that will kick-start the fund and draw in private investors to provide the remaining $100 billion. Potential sponsors who have publicly backed the initiative include China, the United Arab Emirates, Germany, Norway, France, and the U.K., though not the U.S. But so far only Brazil has committed funds: Lula pledged $1 billion at the U.N. General Assembly in September. And in the run-up to Belém, there have been reports of other potential sponsoring governments shying away from cash commitments.

Britain, for instance, has worked closely with Brazil in devising the TFFF. Speaking at the London Climate Week, British climate change secretary Ed Miliband called it "bold, inspiring and incredibly promising." But officials spoken to for this article say that, with budgets tight, there is little chance of British funding being announced in Belém.

That said, the World Bank taking the reins will encourage wavering governments that the project is viable. Whether it is a boon for tropical forests or another false dawn may take longer to establish.

Fred Pearce
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Invitation to Consortium on Legacy Forest Information Resources

We have a new Task Force under the International Union of Forest Research Organizations (IUFRO) focused on rescuing old forest data from around the world that are not yet protected. But they urgently needed for understanding the current rapid environmental change. (See https://www.iufro.org/task-forces/t57-legacy-forest-data-and-related-resources.) These data are found in many institutions and countries. Older forest data are usually still on paper in filing cabinets and boxes and are vulnerable to loss from fire, storms, floods, insects, or being thrown out, or they are in older digital formats which can become unreadable. But they have many uses, including as baselines to compare to changing conditions for forest restoration, improved resource management, and conservation, all of which can contribute to local livelihoods.

Since there are more people interested in joining the Task Force than we could accommodate, we are also forming a Consortium linked to the Task Force, so all can participate who are interested in in the discovery, rescue, and use of legacy forest information. Consortium members will be invited to join and contribute to the online discussion groups on various topics. If you would like to participate in the Consortium, please fill out the Google Form at https://docs.google.com/forms/d/e/1FAIpQLSe1AbTK29G4rpDXdRgBF5nXDP49aWUsIxdDplIwC5oDmZz2cA/viewform?usp=sharing&ouid=116938643400553223925, Please also share this invitation with others.

Sincerely,
Hans Juergen Boehmer, PhD and Sheila Ward, PhD
Coordinators
legacyforestinfo@gmail.com
IUFRO Task Force 57 Legacy Forest Data and Related Resources
https://www.iufro.org/task-forces/t57-legacy-forest-data-and-related-resources

‘Nitrogen fixing’ trees could help tropical forests bounce back, research suggests

Many tropical forests are regenerating on land where forests have previously been chopped down for cattle grazing. Practices like these cause nitrogen to be lost from the soil, which can slow the regrowth of forests. (Credit: Sarah Batterman / Cary Institute of Ecosystem Studies)

On the narrow isthmus of Panama, scientists discovered adding nitrogen to the soil doubled tree growth, providing new insights into forest restoration.

An extra helping of nitrogen can double the growth of tropical trees in a recovering forest, vastly boosting the amount of carbon dioxide (CO_2) they can absorb for a decade, according to a new study. Researchers found that adding a nitrogen fertilizer to the soil in the youngest forests—those that had been pastures less than a year ago—increased their tree biomass by 95% compared with a non-fertilized control group. Ten-year-old forests also bounced back with the nitrogen treatment, showing a 48% increase in growth compared with the control group.

“We all rely on tropical forests to stabilize our climate,” study co-author and principal investigator Sarah Batterman, an associate professor at the University of Leeds and ecosystem ecologist at the Cary Institute of Ecosystem Studies, told Live Science. “They store about half of forest carbon and sequester about 20% of our carbon emissions. But there’s huge uncertainty in whether tropical forests will continue to take up CO2 or will become a source of carbon into the atmosphere in the future. One of the key uncertainties is the role of nutrients in supporting more carbon sequestration and recovery from disturbance.”

Researchers with the Smithsonian Tropical Research Institute (STRI) tracked the growth of trees and woody vine lianas across a four-year period, monitoring how fertilizers of nitrogen, phosphorus or a combination of both would impact growth. Working in plots around the Panama Canal watershed, they also tested responses across a gradient of forest types, including areas that had been cattle pastures less than a year prior, 10-year-old recovering forests, 30-year-old recovering forests and 600-year-old forests.

For three months each year, field teams fertilized the trees at regular intervals. “You’re driving up and down these steep hills to get to the field site,” Batterman said. “And it’s super beautiful. You can see the Panama Canal in the distance, with the big ships driving through. And then you’re driving through this landscape of pastures with cows and some forests in different stages of recovery.”

After hikes ranging from five minutes to an hour and a half, the field teams would fertilize the trees and measure their trunks. “It’s superhot and sweaty, lots of mosquitoes and insects,” Batterman said. From the diameter of the tree trunks, researchers can extrapolate the aboveground biomass of the trees and, importantly, their carbon storage.

The team’s findings, published Jan. 13 in the journal *Nature Communications,* showed that nitrogen almost doubled growth in the areas that had been agricultural land until a year prior and boosted growth by almost 50% in forests that had been recovering for 10 years.

Older forests showed no response to the extra nitrogen, and no forests showed a response to the phosphorus fertilizer.

When trees are harvested from tropical rainforests, the soil below is also degraded, with nutrients like nitrogen and

A root nodule on a legume tree where symbiotic bacteria fix nitrogen from the atmosphere into a form of nitrogen that the trees can use to grow. Legume trees are abundant in tropical forests and can be used in reforestation efforts to naturally enrich the soil with nitrogen that speeds up carbon sequestration and storage. (Credit: Sarah Batterman / Cary Institute of Ecosystem Studies)

phosphorus being depleted. This degradation is still detectable decades after deforestation.

But rather than suggesting we physically fertilize vast tropical forests with nitrogen, the new findings can be used to plan forest recovery projects that prioritize tree species that can convert atmospheric nitrogen into a nutrient. This is known as "nitrogen fixing trees," study co-author Jefferson Hall, director of the Agua Salud project at STRI, which provided some of the forest plots where the experiment took place.

"It's not practical that people are going to go out and, you know, fertilize all the forests of the world to capture CO_2," Hall told Live Science. "The natural way of enhancing the nitrogen system would be to plant more nitrogen-fixing trees."

Richard Birdsey, a senior scientist at the Woodwell Climate Research Center who was not involved in the study, said the findings confirmed a long-standing observation about nutrients. "When I went to school, 50 years ago, the issue of nutrient depletion in tropical forests was known at that time. But no experiments like this had been done. It was simply some observations," he told Live Science.

Former tropical forests that had been removed, most often for agriculture, lack nutrients in the soil, and it often takes a long time for these nutrients to rebuild—even when the land is reforested. "The study, in a way, confirms these long-held beliefs about how tropical forests operate and what happens to them when they're harvested," Birdsey said.

Birdsey, who was with the U.S. Forest Service for over four decades, said recovering tropical forests are a vital global carbon sink, meaning they absorb more carbon than they release.

"They take up about 2.5 pentagrams of carbon per year," he said. "Globally, forests take up something like 3.5 pentagrams. So tropical forests, overall, are the biggest component of the carbon sink. And tropical regrowth forests, or regenerating forests, are the biggest part of the tropical forest sink."

livescience.com

Roots of Resilience: The Women Preserving Asia's Ancient Mangrove Forest

Members of AgniKanya display seed pods from the various types of mangrove that they plant, each of which is suited to different soil and water conditions. (Credit: SEEDS)

Straddling the border between India and Bangladesh, where the rivers Ganges, Meghna and Brahmaputra converge and flow into the Bay of Bengal, an ancient forest of mangroves stretches over 3,860 square miles. This labyrinth of misty saltwater channels, mudflats and marshy land known as the Sundarbans is the world's largest mangrove forest, and home to millions whose lives are tied to the tides.

But over the years, those living here—all mostly dependent on farming and fishing—have watched these tides turn hostile, with rising sea levels, increased salinity in the soil, and cyclones

like Aila (2009), Amphan (2020) and Remal (2024) battering both the Sundarbans ecosystem and the communities that depend on it. "With every high tide and storm surge, more salt is deposited in our fields, making them infertile," Poornima Bhunia says. Her son is among tens of thousands of Sundarbans locals who have left their villages to diversify household incomes in the face of vulnerability to extreme weather and environmental degradation.

Traditionally after a natural disaster, NGOs come in for a period of time, bringing relief that focuses on urgent needs, such as repairing homes, distributing food and restoring water. But after Cyclone Amphan wreaked havoc in the region in 2020, the Sustainable Environment and Ecological Development Society (SEEDS), an NGO that works to develop resilience to climate change impacts across India, realized recovery couldn't just be about rebuilding what was lost. As they worked with people who were bearing the brunt of increasingly more intense climate events year on year, it became apparent that they needed to help prepare the land, as well as the people, for the next storm.

In the Sundarbans, the solution was all around them: Mangroves, often referred to as one of the "big three" marine ecosystems, together with salt marshes and seagrass beds. Between them, they account for over 50 percent of carbon storage in oceans, and mangroves are surprisingly effective in reducing the speed and intensity of tsunamis and tidal surges. "We decided to plant mangrove saplings along degraded coastlines so that they'd provide a natural green buffer against the waves," says Yezdani Rahman, chief of programs at SEEDS.

The key, says Rahman, was integrating the initiative into the local community. Many living in the villages dotting the Sundarbans landscape had been battered, not just by the frequent cyclones and tidal surges but also by a crippling lack of jobs and opportunities. "We realized that the only way to ensure the long term sustainability of our mangrove restoration project was to link local livelihoods directly to it," Rahman says. With local field partners, mangrove restoration experts and villagers—those who have "folk wisdom that has evolved through generations of living with mangroves in the Sundarbans," says Rahman—SEEDS enlisted women's self-help groups (SHGs) in Sundarbans villages, including the one Bhunia belongs to, to plant mangroves along embankments near the water. These small voluntary collectives in Indian villages usually engage in collective action, and sometimes also support members with microloans from the corpus created through monthly contributions. SEEDS turned them into mangrove protectors.

"We learnt to identify new sites for plantation, how to intercrop different mangrove species with native grasses, and how to maintain existing mangroves in low tide areas," Bhunia says. "One day this will become a green wall that will protect us from storms and high tides. The Sundarbans are my motherland, but she no longer nurtures us like she used to."

Other women's groups like *AgniKanya* ("fiery girls" in Bengali) in Uttar Baikunthpur, which is close to the tiger reserve in the Sunderbans delta, started small mangrove nurseries.

Every other day, 52-year-old Thakur Dashi Shee, a senior member of *AgniKanya* who lives in a temporary house on the water's edge, wades into the water looking for mangrove fruit before breaking them open and carefully extracting the seeds. She says that last year *AgniKanya* planted 20,000 saplings—"this year we hope to double that number"—and made a profit of about Rs 60,000 (about $660). The group found buyers in the forest department, NGOs and private parties from across the country, and hopes that the demand (and their income) will increase in the coming years.

Thakur Dashi Shee. (Credit: SEEDS)

By building the capacities of dozens of such women's groups, SEEDS has developed what they call an "ecology as economy" model in which protecting mangroves and improving the ecology of the Sundarbans directly contributes to the local economy.

And it seems to be working. Dashi Shee says that since *AgniKanya* fortified their embankments two years ago, they have observed that they have escaped relatively unscathed from natural disasters compared to embankments with no plantation on them. After Cyclone Remal in 2024 caused minimal damage in their mangrove plantation areas, she says that even the village leaders have become interested in joining the SHG's efforts.

The ecosystem benefits of mangroves have been extensively researched. There is evidence that forested wetlands such as mangroves can sufficiently reduce record-high waves during storms, functioning as a form of nature-based coastal protection. And when the 2004 Indian Ocean tsunami hit coasts of Thailand, Sri Lanka and India, areas located behind mangrove forests suffered less damage compared to exposed areas, especially those in southeastern India. This was probably because mangrove forests that are at least 1,600 feet wide are able to absorb over 75 percent of the incoming wave energy.

The Sundarbans, a UNESCO world heritage site, was declared endangered in 2020 by the International Union for Conservation of Nature. Much of its deterioration is manmade—a result of a perception that mangroves are "wastelands" of no value, economic or environmental. "Unrestrained coastal development, fishing, deforestation and other human activity has resulted in tremendous degradation of the mangrove systems

Members of the Pallisbree SHG plant mangrove saplings in the Sundarbans. (Credit: SEEDS)

in the Sundarbans," says Dr Krishna Ray, associate professor of botany at West Bengal State University and an expert in restoring mangrove habitats.

In 2014, Ray began restoring a severely degraded area at a confluence of three rivers in the Sundarbans that was deeply vulnerable to flooding. Using multiple mangrove species and native grasses to reduce erosion, improve the plantation's carbon sequestration potential and stay true to the original Sundarbans habitat, she observed that it took about five years of stewardship before the saplings could survive on their own. Ray's project, which ran for 10 years in total, has now become "dense and impenetrable," she says—the ideal outcome. Moreover, the trees in the area have now begun multiplying without human intervention. "70 percent of the new growth has come up on its own, we planted only 30 percent," she says.

In 2020, when Cyclone Amphan made landfall close to Ray's plantation site, she predicted "utter devastation," she recalls. "I thought my first site was totally lost." But it was actually intact, thanks to the multiple mangrove species that supported each other, and native grasses that protected the embankment.

Positives aside, Ray worries about the future of the mangroves she so painstakingly restored, now that the project has ended and there are no funds to continue to pay local community members to protect it.

Perhaps this is what makes SEEDS' "ecology as economy" model replicable and sustainable. Women's SHGs have found multiple sources of income from mangrove nurseries, embankment protection and selling associated crafts. Moreover, through training and seeing how mangrove plantations act as effective barriers against the tide, many have developed a sense of ownership and pride towards them.

And the numbers are encouraging. SEEDS has scaled its plantation from 5,500 saplings in 2020 to over 415,000 saplings planted across more than 42 hectares in 2025. 17 women's groups manage mangrove nurseries in the Sundarbans and, based on the work they've been doing there, the NGO is developing similar nature-based solutions for other flood-prone regions in India.

But restoring mangroves in the Sundarbans is not without challenges. Researchers estimate that rising sea levels and salinity could cause the Indian Sundarbans mangroves to lose between 42 to 80 percent of their current area by the end of this century. Rising tides have intensified the salinity of the soil, and this has promoted the proliferation of salt-tolerant but less carbon-rich mangrove varieties, while populations of the Sundari (*Heritiera fomes*), the species after which the Sundarbans was named, have fallen. Mangrove restoration projects are also hampered by fragmented governance, short-lived planting programs lacking long-term scientific backing, and weak enforcement—all contributing to patchwork outcomes rather than extensive living landscapes.

Moreover, ecologists working on the bio-restoration of mangroves in the Sundarbans are deeply critical of the use of vetiver grass to stabilize embankments, as it is not native to the area. Ray is one of them. "Vetiver is not at all salt-tolerant," she says, adding that plantation areas are inundated with saltwater every six hours because of the Sundarbans' unique tidal cycle. "In the intertidal zone, which is the actual abode of mangroves, this vetiver will never, ever grow."

Back in her home on the water's edge, Bhunia waits for her migrant son to return home and worries about the next big cyclone. But every time they sell a mangrove sapling, she feels happy as she is earning with dignity—all without leaving her village. She and others in her SHG plan to reinvest some of their income in mangrove restoration, save some for emergencies and put the rest into nest eggs to fund future small businesses. While building living mangrove walls could take years to show tangible, large-scale impact in the Sundarbans, their work goes to show that linking the local economy to restoring local ecology is a smart defense against the impacts of climate change.

Geetanjali Krishna
reasonstobecheerful.world

Strengthening the Concession Model for Sustainable Forest Management in the Peruvian Amazon: Evidence from Madre de Dios[1]

Secondary road in the Maderacre forestry concession. (Credit: C. Sabogal)

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Summary
This policy paper synthesises lessons from three sustainable forest management (SFM) experiences in timber concessions in Madre de Dios, Peruvian Amazon. The cases of *Maderacre S.A.C.*, *Forestal Otorongo S.A.C.*, and the *Comunidad Nativa Bélgica* demonstrate that well-managed forest concessions can simultaneously provide legal timber, conserve biodiversity, and improve local livelihoods. Drawing on document review, interviews, and comparative analysis, this study identifies key enabling conditions: sound planning, verifiable reduced-impact logging (RIL), traceability systems, and stable institutional frameworks. It also highlights barriers including limited access to finance, inconsistent supervision, and weak policy coherence. The findings support the need for a performance-based concession regime integrating environmental, social, and economic indicators, and offer policy and practical recommendations to strengthen sustainable forest governance in tropical production landscapes.

Key messages

1. Well-managed forest concessions are efficient tools for maintaining forest cover, generating formal employment, and reducing deforestation
2. Reduced-impact logging (RIL) and digital traceability underpin both technical sustainability and market credibility
3. Aligning public policy, fiscal incentives, and transparent monitoring is vital for scaling the model nationally
4. The concession system should evolve toward performance-based management, with measurable outcomes and multi-actor partnerships
5. The successful experiences in Madre de Dios provide a solid foundation to reform and revitalise Peru's national concession system

[1] *This is a revised version of the version published in Spanish in* ***Revista Forestal del Perú****, 39(2): 335–376 (2024)*

Sustainable forest management (SFM) in Peru faces the challenge of consolidating itself as a viable model for conservation and development across the Amazon. Through an analysis of three representative experiences —*Maderacre S.A.C.*, *Forestal Otorongo S.A.C.*, and the *Comunidad Nativa Bélgica*—the study identifies the principal success factors, persistent constraints, and implications for national forest policy and field practice.

The evidence confirms that the concession model can be effective, inclusive, and environmentally sound when it combines technical rigour, transparent traceability, strong social engagement, and suitable financing mechanisms. Nevertheless, persistent instability of institutions, limited access to credit, and fragmented governance frameworks continue to weaken the model's long-term sustainability.

Context and approach

Peru adopted its forest concession model in the early 2000s to promote sustainable use of Amazonian forests. Nearly 9.7 million hectares (ha) have been granted, of which about 2.4 million remain active (SERFOR 2024). Despite notable progress in policy design, many concessions still suffer from low profitability, partial abandonment, and limited technical supervision, restricting their economic contribution and environmental performance.

Madre de Dios, in the southern Peruvian Amazon, holds a high concentration of active and FSC-certified concessions and thus functions as a living laboratory for tropical forest management innovation.

This *policy brief* draws on the article *"Casos de manejo sostenible de concesiones forestales maderables en Madre de Dios, Perú"* (*Sabogal et al.*, 2025), published in the *Revista Forestal del Perú*. The analysis used documentary review, semi-structured interviews, and comparative evaluation of three representative models—entrepreneurial, industrial, and communal—to identify enabling conditions, effective practices, and institutional opportunities for improvement.

Key findings

The three cases illustrate complementary modalities of SFM in the Peruvian Amazon. Despite clear differences in scale, organisation, and markets, all share strong planning systems, transparent traceability, commitment to conservation, and tangible local socio-economic benefits.

***Maderacre S.A.C.*: entrepreneurial management with climate and social focus**

Located in Iñapari District, Maderacre manages over 220 000 ha of production forest certified by the Forest Stewardship Council (FSC). It participates in the Madre de Dios Amazon REDD+ Project (VCS 1493 / CCB Gold), combining reduced-impact logging (RIL) with forest-carbon conservation and targeted social investments.

Its operational planning, systematic inventorying, and post-harvest monitoring ensure sustained yields and natural regeneration. The firm reinvests part of its income from timber and carbon credits into local social projects—environmental education, territorial surveillance, and infrastructure support—making it one of the few enterprises that simultaneously addresses climate, community, and production goals.

Maderacre's case demonstrates that large-scale private operations can integrate climate-finance mechanisms and social responsibility within a viable commercial model.

***Forestal Otorongo S.A.C.:* industrial efficiency and certified traceability**

Forestal Otorongo, part of the Bozovich Group, manages 81 000 ha in the District of Iberia under FSC certification for both forest management and chain-of-custody (FM + CoC). The company has achieved full vertical integration, linking forest harvesting to industrial processing at its mill in Puerto Maldonado.

This structure guarantees traceability of every log from stump to export and ensures compliance with legal and environmental standards. Its use of advanced machinery and planning software improves log recovery rates while minimising waste.

Ot*orongo*'s strategy also involves partnerships with neighbouring communities for the collection of Brazil nuts (*Bertholletia excelsa*) and for employment opportunities. The case confirms that industrial competitiveness can coexist with environmental stewardship and local inclusion.

***Comunidad Nativa Bélgica*: community-based management and territorial governance**

The *Comunidad Nativa Bélgica* of the Yine people, in Iñapari District, administers 53 394 ha of titled land, of which about 85% are designated for forest management. With technical support from AIDER (*Asociación para la Investigación y Desarrollo Integral*) and the USAID ProBosques Programme, the community has strengthened its forest planning, territorial control, and participatory monitoring.

The integration of timber harvesting with Brazil-nut collection and other non-timber forest products (NTFP) has improved livelihoods while maintaining ecosystem integrity. Participatory mapping and the establishment of control posts have reduced illegal incursions and increased communal capacity for adaptive management.

This case highlights that when tenure security, external support, and social organisation converge, community forestry can be both profitable and ecologically sustainable.

Table 1. Comparative indicators of production, yields, certification, and employment

Indicator	Maderacre	Otorongo	CN Bélgica	Source
Area (ha)	220 844	81 238	53 394	Sabogal et al. (2025)
Harvested volume (m³/año)	12 000	10 000	2 000	idem
Yield (m³/ha)	8	9	5	idem
Avoided emissions (tCO_2)	22,000,000	-	-	Paskay (2022)
Direct employment	220	160	45	FAO (2018)
Certification / REDD+	FSC + REDD+	FSC	No	Sabogal et al. (2025)

Operations management personnel in daily briefing before heading out into the field at the Maderacre forestry concession. (Credit: C. Sabogal)

Comparative synthesis

Across the three experiences:

- ***Planning and operational control*** — Annual operational plans and systematic use of RIL have reduced collateral damage and enhanced regeneration
- ***Transparency and traceability*** — Certification and third-party audits improve market confidence and visibility
- ***Diversification of income*** — Timber, NTFPs, and carbon credits together buffer market volatility
- ***Local governance*** — Multi-actor partnerships strengthen legitimacy and control over forest resources
- ***Persistent challenges*** — Institutional weaknesses, illegal timber competition, and scarce financial instruments limit replication of these successful cases

Implications for forest policy and field management

These findings demonstrate that **sustainable concessions can reconcile forest use and conservation** if backed by coherent institutions and incentive frameworks. Yet, the current concession regime remains vulnerable to administrative complexity and fragmented oversight.

- **Institutional coherence and stability.** Strengthening coordination among the National Forest and Wildlife Service (SERFOR), the Forest Oversight Supervisory Agency (OSINFOR), and the Ministry of the Environment (MINAM) is crucial. Duplication of mandates and inconsistent enforcement undermine operator confidence and deter investment. Establishing a *Concession Performance Platform* under SERFOR's leadership could harmonise standards and provide transparency
- **Profitability and traceability as twin pillars**. Economic viability depends on coupling production efficiency with verified legality and sustainability. Digital traceability through the National System for Forest and Wildlife Information (SNIFFS) should evolve into a publicly accessible dashboard, allowing concessionaires, authorities, and buyers to monitor operations and ensure compliance. At the same time, integrating traceability with certification and fiscal incentives—for example, tax rebates or preferential procurement for certified timber—would reward good performance
- **From control to performance-based evaluation**. Moving from bureaucratic inspection toward results-based monitoring is essential. Applying the FAO–European Forest Institute (FAO–EFI, 2018) performance indicators —economic, environmental, and social—would allow Peru to rank concession performance transparently and target support to lagging operators. OSINFOR's oversight role could then evolve from sanctioning to coaching, reinforcing a culture of compliance and continuous improvement
- **Strategic projection**. At national scale, revitalised concessions could become the backbone of a low-carbon forest economy contributing to Peru's *Nationally Determined Contribution (NDC)* and to the *Kunming–Montreal Global Biodiversity Framework*. Positioning concessions within jurisdictional climate-finance initiatives and forest-landscape programmes would amplify their environmental and social impacts.

Checkpoint at the entrance to the communal territory of Comunidad Nativa Bélgica. (Credit: C. Sabogal)

Strategic recommendations to strengthen the concession regime

1) **Strengthening the concession-allocation and planning phase.** Conduct prior technical and financial feasibility analyses and introduce pre-qualification of applicants. Integrate territorial zoning and accessibility assessments before awarding contracts to ensure viable and transparent operations
2) **Institutionalise reduced-impact logging (RIL) and field audits.** Adopt RIL as a national mandatory standard. Establish periodic independent field audits with georeferenced data, transforming OSINFOR's oversight into a collaborative, performance-oriented mechanism
3) **Promote market incentives and green finance.** Develop credit lines through national development banks, facilitate access to Green Climate Fund and carbon markets, and launch public-procurement schemes favouring legal, certified timber
4) **Create a national public system for performance monitoring.** Merge SNIFFS and the Self-Assessment Tool (SAT) into a unified, open-access platform reporting adapted key FAO–EFI indicators. Transparency will strengthen accountability and attract responsible investors
5) **Include social and biodiversity targets in concession contracts.** Incorporate verifiable commitments on local employment, benefit-sharing agreements with communities, and protection of high-conservation-value areas, subject to third-party verification
6) **Consolidate public–private–community partnerships.** Establish regional clusters to support certification, technological innovation, and participatory territorial governance, reducing social conflict and enhancing resilience

Together, these measures form a practical **roadmap for renewing Peru's concession regime**, linking productivity, social inclusion, and biodiversity conservation within a measurable and transparent framework.

Conclusions

The experiences of Madre de Dios confirm that **sustainable forest concessions can deliver multiple public goods**—legal timber, biodiversity protection, and rural development—when underpinned by sound planning and stable institutions.

To scale up this model, Peru must strengthen pre-harvest planning, institutionalise verifiable RIL, create financial incentives rewarding sustainability, and operationalise transparent performance monitoring.

The strategic challenge is to transform the concession system into a **pillar of Peru's sustainable, low-carbon forest economy**, aligning successful local practices with coherent national policies and international climate-and-biodiversity commitments.

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The Lost Forests of Sindh

It is estimated that Sindh has lost nearly 80 per cent of its forest cover since Pakistan came into being, much of it in the last 30 years.

Near the Thatta-Karachi bypass, a *rabrri* [a condensed milk-based dessert] seller in his late thirties stands behind his roadside stall as sweat carves clean lines through the dust on his face. There are no trees nearby, no shade. There is only the open road and the sun beating straight down.

The *rabrri* seller speaks about what Makli (located near Thatta in Sindh) used to be like two decades ago. "Even summers felt different then," he says. In those days, thick trees lined the road, holding back the heat. Some evenings even brought a light drizzle, settling the dust and softening the air.

People lingered outside and animals existed in their natural habitats. It seemed like there was a balance to things and a natural order. But now, there is only heat—and the trucks.

Manufacturing heat

A truck loaded with freshly cut wood thunders past. Then another. Then another. All of them are headed towards Karachi with engines roaring, and timber stacked high and loose. Tree varieties of *neem*, *babul* and *keekarr* are all piled atop this truck. Their trunks look thick enough to have been standing for decades.

The trucks passing the *rabrri* seller's stall are not an anomaly. They form a steady, visible supply chain running from lower Sindh into Karachi. Each one of these trucks carries with it more than wood. These trucks carry away shade from roads such as this one in Makli, cover from fields and riverbanks across Sindh, the homes of various local animals and birds, and the natural setting that gives rise to flora and fauna.

Trucks barrelling across Sindh loaded with illegally cut timber have become an alarmingly routine sight in the province. It is estimated that Sindh has lost nearly 80 percent of its forest cover since Pakistan came into being, much of it in the last 30 years. As this rabid deforestation in Sindh has led to heat-waves and other related calamities year-after-year, are officials simply turning a blind eye, or are they complicit? What policies have led us to this juncture, and can anything be done to reverse the damage?

According to numerous studies, deforestation and the removal of trees is directly linked to an increase in the intensity and frequency of heatwaves. Research shows that cutting down forests removes the cooling effect that trees provide, leading to local surface temperature increases of up to 4.5 degrees Celsius. As a result of this slow, engineered erasure of the natural ecosystem across Sindh, hundreds of people and livestock are dying every year in the province, as recurring heatwaves continue to ravage the land.

According to a news report published in *Dawn* on June 22, 2025, the Provincial Disaster Management Authority (PDMA) Sindh stated that "the 2024 heatwave alone led to 5,358 hospital admissions for heat-related illnesses and 158 livestock deaths. During the period between April and May, 2025, 675 heatstroke cases were treated across the province. Overall, an estimated 8.6 million people across 26 districts in Sindh faced heightened food insecurity due to compounding heat and drought risks."

This naturally begs the question: given the direct causation between deforestation and the increase in heat-related calamities and ailments, why are the authorities in the province allowing Sindh's trees to be mowed down?

According to drivers and residents familiar with these routes, each truck pays around Rs 4,000 to officials from the Sindh Forest Department in order to move freely across these lands. Trucks carrying timber from Tharparkar, Badin, Sujawal, Thatta and lower Sindh funnel onto the National Highway N-5 for Karachi. On average, one truck passes every 15 minutes. That amounts to roughly 96 trucks a day. On a single route, that is Rs 384,000 changing hands daily. Over a month, the figure exceeds Rs 11.5 million. A truck driver tells *Eos*, "Pay and you can go anywhere. If you don't pay, then you're in trouble." None of the trucks display visible permits and none of them are stopped for inspection at checkpoints.

The Sindh Forest Department, which has publicly emphasised reclamation of encroached lands and afforestation drives, did not respond to requests for comments on the operation of these trucks and the seeming absence of any checks and balances.

These trucks that have, in the words of the *rabrri* seller, "eaten everything" did not appear overnight. In fact, Sindh's forests have been slowly dismantled in stages over nearly two centuries now, but the scale and impact has never been this large.

A history of destruction

When the British annexed Sindh in 1843, the Indus riverine forests were among the first landscapes to be surveyed, mapped and claimed. Timber from babul and keekarr fed railway expansion, cantonments and canal construction. Forests ceased to be living systems and became inventories. Large stretches of riverine forests were cleared to serve colonial infrastructure and revenue needs as floodplains were also regulated.

In 1932, the Sukkur Barrage diverted water, thus reducing inundations and riverine regeneration. After Partition, the same logic persisted, as Pakistan inherited colonial forest laws. In 1947, the Sindh Forest Department inherited and managed 269,511 hectares of reserved forests and 24,369 hectares of protected forests, mainly riverine forests along the Indus floodplains. These figures marked the baseline for productive cover in the province, with dense stands of *babul*, *keekarr* and other species regenerating naturally through annual inundations.

Since then, the nominal area of riverine forests has stayed roughly stable on official records at 241,198 hectares, as per the Sindh Forest Department, reflecting a modest nominal decline of about 28,313 hectares from the 1947 reserved figure.

Yet, the effective loss is much steeper due to degradation, encroachment, illegal felling and reduced freshwater flows from barrages. Estimates indicate that up to 80 per cent of riverine forests have been destroyed or heavily degraded.

By the 1950s, barrages such as Guddu and Kotri intensified the issue. The average annual flow from the Kotri Barrage dropped from 41 million acre-feet (MAF) during 1976–1998 to 14 MAF during 1999–2023. By the 1980s and 1990s, forest land in Sindh increasingly existed only on paper. Forest boundary pillars disappeared, while guards were few, poorly paid and easily overruled.

Between the 1980s and early 2000s, Sindh's forest cover declined drastically, with riverine forests in some areas shrinking by more than two-thirds or more—from over 20 percent to under seven percent of mapped study areas. Province-wide, Sindh likely lost 50 to 80 percent of its forested areas compared to its mid-20th century levels, with most of that reduction happening through the late 20th century and into the early 2000s.

Policy failures

In 2005, the Sindh government introduced its Agroforestry Policy, officially aimed at increasing tree cover through private participation. In practice, it opened vast tracts of riverine and irrigated forests to leasing. Natural forests were often cleared first and replantation was promised later. But oversight weakened as plantation targets were rarely enforced and influential landlords received leases. Environmental impact assessments arrived years late, if at all.

As a result, while it was designed to increase tree cover by engaging local communities, the policy led to widespread deforestation, as land was often acquired by individuals who prioritised agricultural cultivation over planting trees. Despite this, by 2010, the policy was expanded. Lease terms were

Men piling timber near the Kharochan Jetty: in rural Sindh, landlessness and debt pushes labourers into forest-cutting

relaxed and more land was handed out as forests continued to vanish. In 2014, the policy was officially scrapped. The government announced the reclamation and restoration of encroached lands.

According to the Sindh Sustainable Forest Management Policy 2019, published on May 18, 2023 and available on the Sindh Forest Department's website, one of the major factors behind the decrease in forest cover has been the "weak law enforcement of the forestry administration." It also cites the Agroforestry Lease Policy of 2005 as being "detrimental for the forests."

The Sindh Forest Department has routinely taken budgetary allocations from provincial and federal governments specifically for the purpose of reclaiming encroached forest lands. But a persistent critique from environmental groups and after media investigations is that a cycle has been created, where funds are drawn for clearance operations while powerful encroachers are still allowed to delay or avoid eviction, thus letting the deforestation continue. This highlights a recurring failure of governance, where policies—whether for leasing or for reclamation—are undermined by weak enforcement and a lack of transparency.

According to the Sindhi newspaper *Pehnji Ikhbar*, as of January 25, 2026, 75,000 acres of forest department land in Matiari have continuously been handed over to contractors who permit tree-cutting. Despite court orders and government restrictions, wood is still being cut from forest lands and government lands are being cultivated, with the forest department remaining a silent spectator.

Furthermore, the Nasri Forest in Shaheed Benazirabad district (previously known as Nawabshah) has been granted to Bahria Town for the development of their third mega project in the area. Environmentalists and local residents have raised concerns that this move will lead to large-scale deforestation, an increase in temperature, loss of biodiversity and the disruption of the local ecosystem.

Ignorance or complicity?

Ayaz Samoo has been cutting wood for over 20 years. He has spent decades working in forests, felling trees with skill and precision—first with axes and saws, now with machines. He used to cut trees by relying only on strength, experience and patience. "Back then, it was all hands and sweat," he says. "Every tree has its own rhythm. You had to move carefully, understand it, or you could get hurt."

Today, machines have changed his work. Chainsaws roar through the forest where once only the sound of axes filled the air. "It is faster now, yes," he explains, "but you do not 'feel' the tree in the same way." That's because cutting down trees has become a ruthlessly profitable business that is coming at the cost of the province and its people.

Advocate Ammar Dayo, a vocal campaigner against deforestation and climate destruction in northern Sindh, calls the situation in Ghotki district "unprecedented". "During the last three years, forest destruction here has reached levels never seen before," he says.

"The years 2024 and 2025 have been catastrophic for the following forests: Mirpur, Jahanpur, Adilpur, Jarwar, Sardar, Sandrani and Ronte. "The Sindh Forest Department is 100 percent involved in this," Dayo claims. "From conservators to DFOs [divisional forest officers] to guards. Along with them, influential politicians, landlords, the police and even some local residents are involved."

In the Mirpur and Jahanpur forests, Dayo says mature *babul* trees—worth Rs 300,000 to Rs 400,000 per tree—have been cut and sold by the thousands. In Jror, Adilpur and Ronte forests, he estimates millions of *keekarr* and *babul* trees have been removed.

Court orders banning sawmills within 10 kilometres of forest boundaries exist. On the ground, however, sawmills operate inside forest limits, cutting timber into planks and beams that are then loaded on to trucks. But the men cutting the trees are not the men profiting from them.

In rural Sindh, landlessness and debt pushes labourers into forest-cutting. Daily wages are low, work is seasonal and

alternatives are scarce as timber offers quick cash. The legal, ecological and climatic concerns are abstract to these men. Their hunger is not. A cutter in Sujawal tells *Eos*, "We cut for 500 rupees a day. The agents pay us and we use the money to get food for ourselves and our families."

But this is only a short-term monetary fix for a long-term monetary disaster. As forests shrink, pastoralists lose grazing land, heat exposure increases, livestock dwindles, families migrate towards cities already stretched thin and poverty deepens.

A man-made calamity

Environmental expert Nasir Panhwar describes riverine forests not just as scenery but as infrastructure, and this infrastructure is being dismantled. "Biodiversity has been lost," Panhwar says. "Some flora and fauna have disappeared entirely. Migration is underway because livelihoods dependent on forests and water are collapsing." He estimates that up to 80 per cent of Sindh's riverine forests have been destroyed.

Official figures by the Sindh Forest Department paint a similar picture. Productive forests—riverine and irrigated plantations—now account for around just two per cent of Sindh's land area. Nationally, Pakistan's forest cover stands at around 4.7 per cent, among the lowest in the region.

In Sindh, riverine forests have faced sharper degradation despite nominal stability in managed areas. In Thatta district alone, riverine area fell from 45,128 hectares in 1990 to 36,432 hectares in 2010 and then to 25,888 hectares by 2014—an overall decline of about 43 per cent in that district, with other studies showing up to 89 per cent loss in Thatta's forest cover from 1979 to 2010 (from 35.11 per cent to 2.23 per cent).

As of 2025, Pakistan has only five trees per person, as per the World Wildlife Foundation (WWF) estimates—far below the global average of 422 and the desirable 900 for sustainability. In Sindh, it's lower still due to urban pressures and riverine loss.

And, as forests vanish, heat intensifies. Trees lower surface temperatures, retain moisture and break heatwaves. Without them, roads and fields absorb sunlight. Nights offer no relief. A single mature tree provides shade for 10 people, cools the air by 2–5 degrees Celsius through evapotranspiration and absorbs 22 kilogrammes of carbon dioxide (CO_2) yearly. In order to offset Sindh's heat, one person would need a now-impossible number of around 200–300 trees.

Nisar Laghari, a political activist from Hyderabad, disputes official figures on the scale of forest loss, arguing that even existing data understates the damage. According to him, Miani Forest historically spanned nearly 2,500 acres, stretching from the riverine belt up to Hyderabad Taluka. "Local records still show the forest at 2,500 acres," he says, "but satellite mapping today reduces it to around 1,700 acres, already masking a significant loss."

Laghari alleges that of the land still visible on satellite imagery, 150 to 200 acres have been converted into agricultural fields through political pressure, while much of the remaining area is under illegal occupation. Adjacent to Miani Forest lies the Nawab Muhammad Khan Forest, covering another 500 acres, which he argues must be counted as part of the same ecological system when assessing total deforestation.

"The destruction was not accidental," Laghari says. "It became systematic when forest leases began to be issued, despite the fact that forest land is not legally eligible for leasing." Those leases, he claims, opened the forest to commercial cutting and cultivation, fragmenting what was once a continuous green belt into isolated, degraded patches.

Independent verification of these claims remains limited, but historical maps, satellite imagery and local testimony all point towards decades of gradual, policy-enabled deforestation rather than sudden encroachment.

A truck, packed to the brim with timber, pictured at dusk: these operations continue through the night, despite the Sindh government announcing a ban on night-time transportation of timber and wood materials.

How to right a wrong

Internationally, Pakistan presents itself as a climate victim—and it is. The country ranks among the world's most climate-affected nations as it continues to be battered by floods, heatwaves and many other disasters.

Ironically, Sindh has become a focal point for blue carbon projects, especially mangrove restoration, thus attracting international attention, consultants and seed funding. Carbon credits are calculated, maintenance budgets are allocated and photo opportunities multiply.

But such efforts are futile if the broader picture across Sindh is ignored by the authorities. The province's lungs are being depleted, and those tasked with protecting these forests are instead aiding in their destruction through negligent policymaking and a failure to enforce more stringent measures.

It is important to stress that deforestation in Sindh is a governance failure. The steady disappearance of riverine forests and inland tree cover reflects weak policy frameworks, institutional complicity and the marginalisation of communities who once acted as de facto custodians of the land. Addressing this problem requires more than tree-planting drives or donor-funded campaigns. It demands structural reform, transparency and a reimagining of how forests are governed in the province.

Reforming the Sindh Forest Department must be the starting point. The department currently suffers from overlapping mandates, poor accountability mechanisms and limited independent oversight. Forest officers wield extensive discretionary power

over permits and enforcement, creating opportunities for rent-seeking and collusion with timber mafias. Introducing an independent forest oversight authority could help break this cycle. Regular third-party audits, public disclosure of logging permits and mandatory reporting of forest cover changes would make it harder for illegal activity to thrive under bureaucratic cover.

Closely tied to institutional reform is the need for a clear, enforceable forest policy. Sindh's forest laws are outdated and often poorly aligned with current land-use realities. Ambiguous classifications such as 'protected', 'reserved' and 'unclassed' forests are routinely exploited to justify encroachment and conversion. Updating forest legislation to remove loopholes, clarify land tenure and impose stricter penalties for illegal logging is essential. Equally important is ensuring that these laws are actually enforced, rather than selectively applied against small-scale offenders while large operators go untouched.

Additionally, both the riverine trees and the mangroves in Sindh need the silt from the Indus in order to flourish, so the Indus River must also be allowed to flow if trees are to grow freely in Sindh once again.

Technology can also play a transformative role in improving enforcement and transparency. Satellite imagery, drone surveillance and real-time forest monitoring systems are already being used successfully in other countries to track deforestation. Sindh could adopt some similar tools to create a publicly accessible forest monitoring dashboard, showing changes in tree cover, district by district. When deforestation becomes visible and verifiable, denial becomes harder and accountability easier.

At the same time, economic incentives must be realigned. Deforestation persists in part because cutting trees is often more profitable than conserving them. The provincial government can counter this by expanding payment-for-ecosystem-services schemes, where communities are compensated for maintaining forest cover that provides flood protection, carbon sequestration and climate resilience. Agroforestry models that integrate trees into agricultural land can also reduce pressure on natural forests while supporting rural incomes.

Finally, deforestation in Sindh has persisted because it rarely carries political consequences. Legislators, ministers and senior bureaucrats must be held publicly accountable for forest loss in their jurisdictions. Environmental protection cannot remain a peripheral concern in a province increasingly vulnerable to climate change.

In the end, reversing deforestation in Sindh is less about planting more trees and more about fixing the systems that allow them to be cut down with impunity. Without institutional reform, legal clarity, community involvement and transparent governance, even the most ambitious afforestation campaigns will amount to little more than greenwashing.

These solutions are not anything new or revolutionary, but what remains uncertain is whether the province's political and bureaucratic leadership is willing to implement them.

Of trucks and torment

The trucks do not stop even when the sun sets. Even after the Sindh government announced a ban on night-time transportation of timber and wood materials, which came into effect around November 2025, the loads keep moving in the dark.

The order was meant to curb illegal cutting, give checkpoints better visibility and strengthen forest conservation efforts. But on stretches such as the Thatta-Karachi bypass and the National Highway, N-5, trucks carrying trees continue to roll through the night. Locals say the ban exists mostly on paper, so the wood keeps flowing out from rural Sindh through the night too.

And when the *rabrri* seller will open his stall in the morning once again, the trucks loaded with timber will still be flowing past.

Zuhaib Ahmed Pirzada
dawn.com

Tree bark microbiome has important overlooked role in climate

Tree bark has a total surface area similar to all of the land area on Earth. It is home to a wide range of microbial species unknown to science, and they can either take up or emit gases that have a warming effect on the climate

The bark of a single tree can be home to trillions of bacteria, and these microbes may have an important but neglected role in controlling greenhouse gases in Earth's atmosphere.

The total surface area of tree bark on the planet is thought to be around 143 million square kilometres, nearly as much as the world's total land surface area. This surface makes up an immense microbial habitat known as the caulosphere, but the microbes that live there have received little attention from scientists.

"In a way it's so obvious, but we have always overlooked tree bark," says Bob Leung at Monash University in Melbourne, Australia. "We never thought of microbes on tree bark, but it makes sense, because bacteria are everywhere, and if we can find microbes in soils, on tree leaves, then most likely there will be microbes on bark."

Leung and his colleagues began by studying a wetland species commonly known as paperbark (*Melaleuca quinquenervia*). They found that there were more than 6 trillion bacteria living in or on each square metre of bark, comparable to the volumes found in soil.

Genetic analysis of 114 of these bacteria showed that they mostly came from three bacterial families—Acidobacteriaceae, Mycobacteriaceae and Acetobacteraceae—but all of the species were completely unknown to science.

Remarkably, these microbes have one thing in common: they can use hydrogen, carbon monoxide and methane as fuel to survive. Hydrogen (H_2) isn't itself a greenhouse gas, but

Melaleuca wetland forests in New South Wales, Australia, are hotspots for tree microbial life. (Credit: Luke Jeffrey / Southern Cross University)

through reactions with other molecules it can increase the warming effect of methane in the atmosphere.

The researchers then looked at the bark of another seven Australian tree species from a range of habitats, including casuarinas, gum trees and banksias, measuring, both in the field and in lab conditions, whether the bark of the different species absorbed or emitted greenhouse gases.

They found that all barks consumed hydrogen, carbon monoxide and methane in aerobic conditions when oxygen is available. But when trees are submerged in water and oxygen is limited, such as in swamps, bark microbes switched to producing the same gases.

The team estimates that the total amount of hydrogen absorbed by bark microbes globally is between 0.6 and 1.6 billion kilograms each year, representing as much as 2 per cent of the total atmospheric hydrogen removed.

This is the first time scientists have attempted to assess the contribution of tree bark to atmospheric hydrogen, says team member Luke Jeffrey at Southern Cross University in Lismore, Australia.

"Discovering the hidden role of trees doing more than just capturing carbon dioxide in their wood is very important," says Jeffrey. "They are active cyclers in other greenhouse gases. This is exciting, because H_2 affects the lifetime of methane in our atmosphere, therefore H_2 consumption in bark may help in reducing our growing methane problem."

However, the global picture is highly uncertain, as the team has only sampled eight tree species from eastern Australia. "A lot of work now needs to be done across various forest types, tree species, microbial communities and site conditions," says Jeffrey.

Brett Summerell at the Botanic Gardens of Sydney says the study highlights how little we know about the composition, diversity, abundance and role of microorganisms in bark. "How this might vary across a broader range of tree species, particularly in drier climates such as savannahs and woodlands, is interesting," says Summerell.

It will also be important to understand the interactions between fungi and bacteria in bark, he adds.

James Woodford
newscientist.com

Around the World

Canada/USA: Where Fires Used To Be Frequent, Old Forests Now Face High Risk Of Devastating Blazes

A new analysis shows that the Pacific Northwest's mature and old-growth forests are most at risk of severe wildfire in areas that historically burned frequently at lower severity.

The study by scientists at Oregon State University and USDA Forest Service Research & Development is important because those forests are culturally, economically and ecologically significant, supporting biodiversity while storing vast amounts of carbon, and they are under increasing threat of stand-replacing wildfire.

Researchers used state-of-the-art modeling techniques to gain knowledge that can help guide risk mitigation efforts and return forests to healthier fire regimes.

Led by Bruno Aparicio and Meg Krawchuk of the OSU College of Forestry, the research highlights the impact of fire exclusion by showing that 75% of the forest areas with the biggest risk of severe wildfire are places that used to see widespread low- and mixed-severity fires.

The exclusion of fire from Northwest landscapes began with the disruption of Indigenous fire stewardship, the researchers say. Indigenous peoples were forcibly removed from their lands in the 1850s, and putting out wildfires became federal policy following the Great Fire of 1910, which destroyed several towns and burned an area roughly the size of Connecticut across forests in Idaho, Montana, Washington and British Columbia.

Prior to fire exclusion, frequent low- and mixed-severity fires had played a key role in maintaining the forest ecosystems of the western United States. Since then, older forests and trees have seen major structural shifts as shade-tolerant and fire-intolerant species have moved in.

"Now, as wildfire activity intensifies under climate change, understanding where and why mature and old-growth forests are most vulnerable is essential," said Aparicio, a postdoctoral researcher in Krawchuk's group within the college's Department of Forest Ecosystems and Society. "This work provides a spatial framework to help land managers prioritize where protection may be sufficient, where active restoration is needed, and how fire refugia can be integrated into conservation and wildfire risk planning."

Fire refugia are pockets of landscape less prone to crown fire than adjacent areas and may hold the key for scientists,

conservationists and land managers seeking to preserve vulnerable species in a changing climate.

Informally described as the "lifeboats" or "slow lanes" of biodiversity, refugia have spawned the new field of refugia science, which has learned that some locations have inherent characteristics—such as terrain, vegetation, proximity to bodies of water, and slope-face direction—that can buffer them from stand-replacing fire with a degree of predictability.

In the context of this study, which looked at federal forests in the 24 million acres of western Oregon, Washington and California covered by the Northwest Forest Plan, estimates indicate fire refugia could reduce the overall risk of severe fire by up to 20%. Roughly 7 million acres of the study area are mature or old-growth forest, 1.8 million acres of which is in fire refugia area.

The analysis suggests the study area's subalpine mature and old-growth forests—those at the timberline—are both relatively rare and have high vulnerability, and that the Klamath Mountains are a hotspot for both wildfire exposure and potential carbon emissions.

"Protecting mature and old-growth forests isn't just about preserving the past—it's a key strategy for climate mitigation, ecosystem resilience and long-term forest stewardship," Krawchuk said.

Through the 20th century, the authors note, mature and old-growth forests on national forests saw major declines because of logging. In recent years, wildfire has replaced logging as the largest threat, and since 2000, federal lands have seen a net loss of 2.6 million acres of mature forest and 700,000 acres of old-growth forest. Those acres were designated for multiple uses including recreation, timber production and wildlife habitat, providing important ecosystem services.

"Current trends show a continuous increase in area burned and wildfire severity in the western U.S. over the last decade," Aparicio said. "The increase is driven by a growth in the number of human-caused fires; warmer and drier fire seasons and worse droughts, all exacerbated by climate change; and the presence of landscape fuels created through management and fire-exclusion policies."

Developing land management strategies to address the loss of mature and old-growth forests to stand-replacing wildfire is crucial for maintaining these vital socio-ecological resources, the researchers say. That starts with quantifying the spatial footprint of fire exposure by combining geographic data with fire ecology analytics.

"Our work can help prioritize stewardship actions," Krawchuk said. "Overall, fire exclusion has left historically fire-resistant forests disproportionately exposed to severe fire now. Our analysis can underpin the stewardship of mature and old-growth forests to promote their resistance and resilience."

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Jamaica: Over 2,000 hectares of mangrove forests impacted by Hurricane Melissa

More than 2,000 hectares of mangrove forests across five parishes were impacted by Hurricane Melissa, resulting in the urgent need for restoration and resilience-building efforts. This was disclosed by Manager of the Ecosystems Management Branch at the National Environment and Planning Agency (NEPA), Monique Curtis, during a JIS Think Tank held on Wednesday, January 28.

Curtis said preliminary assessments conducted by NEPA and the Forestry Department revealed a range of impacts on mangrove ecosystems, including defoliation, downed trees, accumulation of solid waste, and storm surge-related sand intrusion extending as far as 130 metres inland in some areas.

"While the loss of trees is visible, what is not always evident is the accumulation of solid waste and the changes in water flow that affect the overall health of these ecosystems," she pointed out.

Curtis said that the damage has disrupted critical ecosystem services provided by mangroves, including coastal protection, fisheries support, water regulation and climate resilience, with direct implications for livelihoods in affected communities.

She noted that, "based on initial assessments, at least eight sites have been identified as priority areas for restoration, including locations along the southern coast of Black River, as well as areas in Westmoreland, Falmouth and Montego Bay."

Restoration activities, Curtis emphasised, extend beyond replanting mangroves, requiring technical, site-specific interventions. "Before planting takes place, there may be a need for sand removal, solid waste clearance and the restoration of natural water flow through channels," she said, noting that in some cases, creating the right environmental conditions allows for natural regeneration without the need for planting.

Curtis added that the restoration work is aligned with existing national frameworks, including the National Mangrove and Swamp Management Plan and the National Ecosystem Restoration Plan, which is nearing completion and identifies coastal ecosystems to be restored over the next decade.

The restoration push is also supported by technical expertise developed through projects implemented since 2009, including partnerships with the University of the West Indies (UWI) international agencies and local stakeholders.

Mangrove restoration forms a central part of Jamaica's climate resilience strategy, particularly along the south coast, where large sections of the population and critical infrastructure are located.

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