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Trees & the Web of Life

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In this edition, we explore the various roles trees have in ecosystems that support the health of humans and other living organisms. Given the significant loss of trees globally due to deforestation, wildfires, and extreme storms in recent history, the world needs far more trees to help clean the air and water, stabilize soil and combat climate change. There is a range of approaches to increasing forested areas. Here, we highlight diverse examples of particular challenges and solutions to protect trees and restore and rewild forest ecosystems.

Trees and Forest Ecosystems

Trees are essential to a healthy life and biodiversity on Earth in a multitude of ways:

- As people encroach on forest ecosystems, the resulting loss of habitats and biodiversity threatens the health of people and the planet. One of the many consequences is increased disease risks, including zoonotic diseases such as COVID-19.
- Forests cover just over four billion hectares of the Earth's surface, which accounts for 31% of global land area—down by around 10% since 1990.
- There are over 60,000 known species of trees globally. As of December 2019, 8,000 of those have been assessed as threatened species.
- Forest ecosystems are complex webs of organisms, providing a rich habitat for literally millions of species of fungi, plants, invertebrates, and animals.

- Trees are essential to the water cycle as they collect water in their roots and release it into the atmosphere.
- Their roots help to retain soil, protecting land-based habitats from soil erosion. On tropical coastlines, mangroves also protect the land from the sea, while providing a richly biodiverse habitat.
- Of people living in extreme poverty around the world, more than 90% rely on forests for all or part of their livelihoods.

Forests have crucial roles in climate regulation, such as absorbing and processing greenhouse gases. Through photosynthesis, trees convert carbon dioxide (CO_2) and water to produce glucose. This results in oxygen (O_2) emissions into the atmosphere, while at the same time, trees accumulate carbon in their biomass and surrounding soil.

Trees, like other plants, transpire the majority of water taken up by their roots, which is then released and evaporated from their aerial parts (leaves, stems, etc.). Transpiration rates vary widely depending on the tree species, soil type, and weather conditions, such as temperature, humidity, sunlight availability and intensity, wind, and precipitation. During dry periods, many trees have the advantage of being able to draw from underground water sources through their deep roots. Tree roots are often wide-spreading, extending radially in any direction for distances often in excess of the tree's height.

The Pando, a clonal colony of a male quaking aspen tree, is widely recognized to be the largest (in mass) known living organism on Earth, and among the oldest. Pando's shared root system is several thousand years old. The colony is located at the western edge of the Colorado Plateau in south-central Utah. It occupies 43.6 hectares (108 acres) and is estimated to weigh 6,000,000 kilograms (6,614 U.S. tons).

Healthy forests have a richly interactive life underground, not least of which, is in the form of mycelium existing as white subterranean strands that form the bulk of a multitude of fungi. These vast networks, dubbed the "Wood Wide Web" by German forester Peter Wohlleben, connect trees and other plants even across long distances.

The fine, hair-like root tips of trees join together with microscopic fungal filaments to form the basic network links. It is a symbiotic relationship wherein the flora provides the fungi with food, with up to 30% of the sugars a tree produces via photosynthesis used by the mycelium. In return, the more efficient mycelium supplies nitrogen, phosphorus, and other mineral nutrients from the soil and into the flora's roots.

The tree/mycelium relationship goes far beyond this direct exchange of resources, however. Trees can actually use the mycelium network as a sophisticated system of exchange *with other trees,* both in terms of resources and other forms of communication that give rise to some surprising emergent capacities. For example, mycelium networks help increase the plant community's resilience to disease, drought, and pests by conferring resistance from infected plants, or via the release of warning signals which trigger defensive responses across the network.

Key nodes (hubs) in these networks are "mother trees"—older, taller trees whose canopies catch the most sunlight. They distribute nutrients to particular smaller neighboring trees through many distinct networks built by up to dozens of strains of mycelium. Hub trees can detect the ill health of their neighbors from distress signals, and send them the nutrients needed to recover. They even display a preference for their offspring and other relatives. Trees can also weaponize these networks, exploiting them to inhibit the growth of competing trees nearby.

Learn more

"The secret language of trees"
(2019) *TED ED*

Conservation and Deforestation

Old-growth forests serve as a reservoir for species that cannot thrive or easily regenerate in younger forests. Thriving old-growth forest ecosystems can be viewed as genetic repositories. Protecting old-growth forests and the biodiversity they contain is vitally important, given the mass extinction era where we find ourselves.

An important strategy for conserving forests is to avoid cutting down mother trees which, as explained earlier, are also forest stewards. The more organisms lost through de-forestation, the fewer opportunities there are to learn and benefit from forests including discovering natural remedies for human illnesses.

- Between 2001 and 2019, a total of 386 million hectares (Mha) of tree cover was lost globally. This tree loss is estimated to have resulted in an excess of around 105 metric gigatons (Gt) of CO2 emissions.
- The total area of humid, primary forest in the world decreased by 5.9% between 2002 and 2019, with the loss of over 60Mha.
- Since 2001, the top three countries with the largest loss of tree cover are Russia (64Mha), Brazil (56.5Mha), and Canada (42.9Mha), with the US a close fourth.

Source: www.globalforestwatch.org

Deforestation can have significant impacts on both weather and climate change in ways that go beyond carbon emissions or sequestration. It's becoming increasingly clear that tropical forests provide the atmosphere with massive amounts of water through transpiration, which then falls as rain sometimes far downwind. By one estimate, the world's vegetation recycles 45 cubic miles of water every single day, with one-tenth of that coming from the Amazon forest alone.

As more of the Amazon is deforested, rainfall reduction is experienced both in the Amazon and as far away as the midwestern United States. These changes can adversely impact the freshwater needs of rural and urban communities, such as Iowa, that rely on evaporation and transpiration from distant ecosystems.

Transpiration and shade cover also create noticeable cooling effects within local climates, and the removal of this cooling through deforestation can raise temperatures considerably. A 2017 study in Sumatra found temperature variations of up to 18°F due to deforestation, which was primarily caused by palm oil production.

Agricultural plants cannot retain the soil as well as the trees that were cleared to cultivate them. Crops like coffee, cotton, palm oil, soybean, and wheat can actually worsen soil erosion. When agricultural fields replace natural vegetation, topsoil is exposed and dries. This decreases the diversity and quantity of microorganisms that help to keep the soil fertile as nutrients are lost. Soil can be blown away by the winds, or washed away by rains. As

land loses its fertile soil, agricultural producers move on, clear more forest and continue the cycle of soil loss. When trees are cut down and burned, their carbon is released back into the atmosphere.

Global Forest Watch (GFW)

- GFW is an open-source web application that monitors global forests in near real-time.
- GFW is a World Resources Institute initiative, with many partners in academic, non-profit, public, and private sector organizations

Forest monitoring is key to the success of conservation efforts. Aided by technical advances, and international networking, more forest data is being collected now than ever before. The services provided by Global Forest Watch allow us access to data on forest conditions, a built-in social media component, and other tools. Citizens, policymakers, and businesses now have an unprecedented ability to monitor forests and woodlands, and respond to challenges.

Restoration and Rewilding

Reforestation approaches range from restoration of complex native mixed-species forests to abandoned land recovering naturally without human intervention. These endeavors have been undertaken around the world with varying success. It is estimated that restored forests currently constitute 7% of global forest cover.

A recent study published in *Nature* undertook the ambitious goal of mapping, at a global scale (to a 1 km resolution), the carbon-sequestration potential of natural forest regrowth. As part of the study, the researchers showed that allowing forests to regrow naturally, as opposed to humans physically planting trees, was more effective in increasing carbon capture, biodiversity, and resilience to disease and pests.

Some nations are undermining reforestation efforts by including commercial plantations in plans to fulfill forest restoration commitments, in some cases up to 50%. This pressure for governments to find often misleading or false "win-wins" with private interests threatens to undermine climate change mitigation work and forest ecosystems' long-term health.

On the bright side, the study suggests that the Intergovernmental Panel on Climate Change is currently underestimating carbon sequestration rates in young forests by around 32% globally, rising to 50% for tropical forests. The model also suggests that allowing forests to regrow naturally could absorb up to 8.9 billion metric tons of CO2 each year through 2050, equivalent to 23% of global CO2 emissions. By mapping global forests with such precision and providing public access, the study authors hope that nations and local communities worldwide can use this information to inform decisions surrounding conservation versus development and strategies for forest restoration.

To be serious about fighting climate change and biodiversity loss, natural forest regrowth must be prioritized over commercial plantations, especially in those areas with the most potential for carbon sequestration and where regions of high biodiversity are threatened. This means allowing the vast, complex, resilient, and self-regulating systems of old-growth forests to spread wherever possible.

The UN Decade on Ecosystem Restoration begins next year. Work is already underway to build the movement.

#GenerationRestoration

Find out more about forest restoration, and how to get involved:

www.decadeonrestoration.org

Steps We Can Take

- Please purchase recycled paper products as much as possible.
- Do not purchase toilet tissue produced by Procter & Gamble, Kimberly-Clark, or Georgia-Pacific, which are the primary companies destroying Canada's boreal forest. Rather than using any recycled materials, they continue to clear-cut ancient trees to make toilet paper from 100% virgin forest fiber.
- Get to know your local forests and advocate for their interests. Local knowledge is an immensely important component of forest stewardship.
- Purchase eco-certified products, such as:
    - Roundtable for Sustainable Palm Oil (RSPO) – Palm oil is among the top commodities driving tropical deforestation and biodiversity loss. The RSPO runs the world's largest palm oil certification program.
    - Rainforest Alliance certification represents their assurance that environmental and social guidelines are followed throughout the chain of custody.
- Advocate for governments to offer financial incentives for landowners and managers to sustainably manage the trees and forests on their land as providers of ecosystem services.

Learn More

"Countries commit to restore global land area the size of China" (November 19, 2020) *UN Environment Programme.*

"Forest financing holds the key to sustainable recovery from COVID-19" (November 16, 2020) *UN Department of Economic and Social Affairs.*

"Contextualizing local landscape initiatives in global change: A scenario study for the High Forest Zone, Ghana" (October 14, 2020) PBL Netherlands Environmental Assessment Agency.

"Putting Ecosystem Restoration First" (October 2020) *International Union of Forest Research Organizations.*

"Young Forests Capture Carbon Quicker than Previously Thought" (September 23, 2020) *World Resources Institute.*

"The Issue with Tissue" (June 24, 2020) *Natural Resources Defense Council*

"Sea-level rise could make rivers more likely to jump course" (August 12, 2020) *California Institute of Technology.*

"The potential of agroforestry to improve food security and land restoration" (April 30, 2020) *FAO-Rwanda*

"Deforestation Intensifies Warming in the Amazon Rain Forest" (September 18, 2019) Scientific American.

"On the Journey to Sustainable Palm Oil" (August 8, 2019) *Rainforest Alliance.*

"Underground Networking: The Amazing Connections Beneath Your Feet" (May 28, 2019) *National Forest Foundation.*

"Global Forest Goals and Targets of the UN Strategic Plan for Forests 2030" (April 2019) *UN Department of Economic and Social Affairs.*

"Wiped out: America's love of luxury toilet paper is destroying Canadian forests" (March 1, 2019).

"Rivers in the Sky: How Deforestation Is Affecting Global Water Cycles" (July 24, 2018) *Yale Environment 360.*

"Do Trees Talk to Each Other?" (March 2018) *Smithsonian Magazine.*

"How trees talk to each other" (2016) *TED.*

"Plants talk to each other using an internet of fungus" (2014) *BBC Earth.*

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Physicians for Social Responsibility - Iowa Chapter

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