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To Combat Climate Change, See the Forest for the Trees

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WHEN MOST PEOPLE conjure a forest, they imagine a dense network of trees, their crowns arching high above, with spots of sunshine flashing between the leaves. Some might also think of birdsong and insects, or summon thoughts of thick foliage in the understory, the crunch of leaves or pine needles underfoot, or overgrown trails meandering into the thicket.

Whatever the particular imagery, it's undoubtedly more picturesque that that conveyed by the <u>United Nations Food and Agriculture Organization</u>'s definition: An area greater than 1.25 acres, populated by trees 16 feet or taller, with more than 10 percent canopy cover. While this simple and straightforward list of attributes might make it easy to classify land, it gives little insight into what a forest can and should look like, which is important because recent research suggests that not all are created equal.

From a climate perspective, forests are vital because they're filled with vegetation, fungi, and microorganisms that draw carbon dioxide from the air and store it. Although just how much CO2 they can absorb <u>may have been overestimated</u>, there's no doubt that ample, healthy forests can provide a relatively low-tech way to help offset greenhouse gas emissions and combat climate change.

Indeed, the United Nations recognized this value when it launched its <u>REDD+ program</u>, which gives developing countries money to <u>protect forests</u> rather than cut them down, and then enshrined the scheme in the <u>Paris Agreement</u> on climate change in 2015. This followed on the <u>Bonn Challenge</u>, launched by Germany and the <u>International Union for Conservation</u> <u>of Nature</u> in 2011, which aimed to restore more than half a million square miles of deforested and degraded land around the world by 2020 and more than double that by 2030.

The private sector has also gotten in on the act, often to make up for other environmentally destructive activities. In April, oil giant Shell <u>pledged \$300 million</u> to offset the carbon emissions of its customers though forest restoration projects in countries such as the Netherlands and Spain.

The problem: Some experts are concerned that these initiatives rely on such an anemic definition of what constitutes a forest that they will ultimately generate far fewer benefits than advocates imagine. In <u>a commentary published in Nature in April</u>, Simon Lewis, a professor of global change science at University College London, Charlotte Wheeler, a forest researcher at the University of Edinburgh, and their co-authors noted that almost half the area pledged under the Bonn Challenge is actually planned plantations that nurture single tree types — usually for timber or food crops. While this may increase the global tally of "forested areas" around the world, the researchers suggest that such plantations will do little to meet the initiative's environmental goals.

"Although these can support local economies, plantations are much poorer at storing carbon than are natural forests, which develop with little or no disturbance from humans," they wrote. "The regular harvesting and clearing of plantations releases stored CO2 back into the atmosphere every 10 to 20 years. By contrast, natural forests continue to sequester carbon for many decades."

And it's not just about carbon. Healthy, mature forests support a broad variety of lifeforms, giving and taking nutrients, habitat, and shade. They catch, store, and filter water. They improve air quality by removing pollutants. And their impacts extend outside their borders; a functioning forest prevents land from being degraded and keeps it productive, can reduce the risk of flooding on lower lying ground, and provides a source of timber, food, medicine, and jobs for people.

To scientists like Lewis and Wheeler, then, the question is whether policymakers can balance competing interests to encourage the sort of conservation and reforestation efforts that will actually do the most good in the shortest amount of time.

THE CURRENT PICTURE of global forests is mixed. According to <u>a letter published</u> last year in Nature, overall tree cover increased by about 7 percent between 1982 and 2016, with losses in tropical regions offset by gains elsewhere.

However, the total amount of forest across the world fell by around 3 percent between 1990 and 2015. By 2015, just 9 percent of ice-free land was covered by primary or intact forest with no or minimal human use, according to <u>a major report on land use</u> published by the Intergovernmental Panel on Climate Change over the summer. Another 22 percent was made up of planted or managed forests used for timber, pulp, or other purposes.

The IPCC stressed that deforestation, particularly in the tropics, is a major source of carbon emissions and concluded that this must be stopped to keep the world from warming more than 1.5 degrees Celsius. At the same time, the report argued that a substantial amount of reforestation (bringing back forests on land where they used to be) and afforestation (planting individual trees or new woodland in places where they haven't traditionally been) will be needed.

Getting the mix right will be key, according to experts who stress that reforestation and afforestation efforts should not supplant work to protect existing forests. Although trees <u>suck up carbon more rapidly in their early years</u>, Lewis and Wheeler note that mature, natural forests are 40 times better than plantations at storing carbon and six times better than agroforestry (where crops and useful trees are grown together).

This is important because tree planting attempts can have unintended consequences. A study of <u>four developing countries</u> that switched from net deforestation to net reforestation between 1961 and 2007 found that most ended up importing more wood and agricultural products from abroad — potentially leading to forest loss or degradation elsewhere.

In China, ambitious national afforestation plans have succeeded in <u>vastly increasing</u> the number of trees. But native forests have effectively been displaced by tree plantations, according to research published in the journal <u>Biological Conservation</u>, and the addition of non-native species could have long-term impacts on the nation's <u>water resources</u>.

"Number one priority is to protect what we have," says Marie Noëlle Keijzer, co-founder and CEO of the Belgium-based not-for-profit <u>WeForest</u>. "The number two priority is to restore; the trees take 10 years to become significant and then 30 years to really have absorbed all the carbon they can absorb, so you don't want to compare a new tree with an existing tree or an existing forest with all the biodiversity and everything there."

Nor should reforestation divert attention from the restoration of less glamorous habitats such as grassland, wetland, peatland, and bog, experts say. The authors of <u>an article on</u> <u>nature-based climate solutions</u> published in June in Nature Climate Change warn that uncontrolled afforestation could threaten some of this treeless terrain, which they found "particularly troubling given that the original habitat can often provide greater and more-resilient carbon storage benefits."

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HOW EXACTLY forest land is restored depends on two key factors: what it currently looks like and what the ultimate aim of reforestation is.

The land might already host a degraded forest, with less tree cover, fewer species, and poorer soil. It may have been deforested, where many trees have been cut down and the land is primarily used for another purpose such as farming or infrastructure. It might be dominated by an invasive species such as lianas — the big woody vines that Tarzan swings from which can quickly take over tropical land — or molinia — a grass that spreads across the Welsh uplands after fields stop being grazed.

In the most extreme cases, the land may even have become incapable of hosting life, but Keijzer says she has never come across a place that can't be restored.

In theory, reforestation in many places could be achieved through natural regeneration, where land is left to return to forest with minimal human intervention. "The safest way to

do it is to find places that will recover naturally and areas that are already near other areas of forests, areas that have just very recently been cut down," says Marshall. "Because you would expect that there would still be some seedstock in the soil and the birds and wildlife will be dispersing seeds."

This option also has the benefit of being cheap, but letting nature take its course is not always feasible for a mixture of practical, social, and economic reasons, and a helping hand is often needed. Across the Sahel Desert in northern Africa, farmers are successfully using a <u>managed natural regeneration technique</u> in which they carefully nurture the remnants of old tree roots under the ground to bring trees back to life.

Afforestt, a company based in India that operates globally, has developed an artificial soil formula that involves brewing a compost 'tea' filled with microorganisms.

And elsewhere more advanced technologies are playing a role. Mangrove trees in Myanmar have been planted using drones designed by the U.K.-based startup <u>Dendra</u> <u>Systems</u> (formerly known as Biocarbon Engineering) to fire seeds directly into fields, for example.

Afforestt founder Shubhendu Sharma sees value in this diversity of approaches: "There are 100 ways to bring back a lost forest," he says. "Like religion, there is one god and different paths to reach that."

XPERTS AGREE that the ultimate aim should be to make the forest sustainable in the long term, which means weighing global, national, and local interests.

Marshall stresses that reforestation must be done in collaboration with those directly affected; after all, there was usually a human reason why the forest was cut down or degraded in the first place. "If people need to feed their families that's massively more important than whether a monkey in the tree is not going to have a place to sleep that night," he says.

At the local level, Keijzer says, simply planting trees is not enough. The forest economy should be designed to benefit residents. This might mean building woodlots for local use, planting exotic species that grow faster and are worth more money alongside native ones, or creating nature reserves with associated tourism jobs. With a sustainable local economy, Keijzer says, people will be less likely to cut down all the trees in order to simply make ends meet.

Keijzer's organization, WeForest, is now working with the U.N. Food and Agriculture Organization to create a formal standard in forest landscape restoration, which will include considerations such as forestry and the livelihoods of local people.

But engaging communities in this work can also provide more than material benefits, according to Andrew Heald, technical director of the Confederation of Forest Industries, or Confor, a U.K. forest industry association. Reforestation schemes that involve local communities can help reconnect people with nature, he says, describing tree planting as a "real kind of statement of optimism in the future of something."

Regardless of how international funding and local resources are brought to bear, a clear focus on smart reforestation which balances benefits to humans and the wider environment is essential because the future for major forests around the world looks increasingly bleak.

The Amazon Rainforest, for example, which absorbs roughly 2.2 billion tons of CO2 annually — about 5 percent of all global carbon emissions — has lost 17 percent of its area over the past 50 years to human encroachment. The commentary on nature-based climate solutions <u>published in June</u> in Nature Climate Change warned that half of the Amazon Basin's tree species could be lost by 2050 due to a combination of climate change and deforestation for cattle grazing, soy farming, and timber. And that doesn't take into account the nearly 5 million acres that burned this past summer.

Roberto Palmieri, deputy executive secretary of Brazilian forestry institute Imaflora, is particularly concerned by the recent blazes, which were mostly the result of cattle ranching. While a deforested area can be restored relatively quickly, with fire "you kill all the life in this place, even underground, the microorganisms inside the soil," he says. "So, wow, a lot more time." A <u>recent study in Scientific Reports</u> raised serious concerns about the Amazon's ability to sustain itself in the longer term, with evidence that deforestation was decreasing the forest's moisture levels.

But Palmieri is optimistic, pointing out that there have been successful restoration projects in the Amazon, both national ones that have prioritized agroforestry and internationallyfunded ones that have sought to restore biodiversity. "What's nice [is] we have a lot of concern now. We also have a lot of technology. You know how to restore that area, you have a lot of assistance to do so," he says. "I think the whole planet is looking."

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