Restoring forests may be our most powerful weapon in fighting climate change

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Restoring forests like the Amazon Rainforest have the potential to offset huge amounts of greenhouse gas emissions, according to new research.

Allowing the Earth's forests to recover could cancel out the majority of humanity's greenhouse gas emissions, according to new research.

The worldwide assessment of current and potential forestation using satellite imagery appears Thursday in the journal Science. It shows that letting saplings regrow on land where forests have been cleared would increase global forested area by one-third and remove 205 billion metric tons of carbon from the atmosphere. That's two thirds of the roughly 300 billion metric tons of carbon humans have put up there since the dawn of the Industrial Revolution.

The findings show forest restoration could be humanity's single most important tool in fighting climate change. "The point is that [reforestation is] so much more vastly powerful than anyone ever expected," said Thomas Crowther, a professor of environmental systems science at ETH Zurich and a coauthor of the paper. "By far it's the top climate change solution in terms of carbon storage potential."

The message here for policymakers is this: supporting natural systems should be a major component of any climate change mitigation strategy — in addition to deploying clean energy, switching to electric vehicles, and curbing consumption overall.

The challenges of such a massive reforestation effort are immense, however: deforestation is still rampant and is accelerating in some parts of the world. Rather than building up forests as a resource to offset greenhouse gas emissions, we're currently losing them, and emitting more carbon in the process.

If the goal is to fight climate change, countries have to reverse course on how they use forests. Another paper out this week in Science Advances offers clear advice on where to focus: the places on Earth where forest restoration would be most viable and beneficial to human societies. As average temperatures keep climbing, forests may lose their effectiveness in soaking up emissions, so time is running out.

There's a huge potential for forest restoration, but we're still moving in the wrong direction

Let's take a moment to recall why plants are so critical to the global carbon cycle.

All plants use sunlight, water, soil nutrients, and carbon carbon dioxide to generate energy and to grow. These plants then die and decay. This returns some of the carbon back to the sky and leaves some carbon in the ground. Over time, this leads to a net reduction of carbon in the atmosphere. Plants also move moisture into the air and release aerosols that can contribute to precipitation.

So plants in general and trees in particular play important roles in regulating weather and the climate around the world.

Humans have disrupted many of these patterns. Since the dawn of civilization, humans have cut down 46 percent of all trees. Just since 1990, the world has lost 1.3 million square kilometers of forested area. The situation is even more dire in the tropics, where less than half of forests remain standing today.

The modern world's insatiable appetite for wood, land, agriculture, and mineral extraction continues drive deforestation. In the Amazon rainforest, one soccer field-sized area is clear cut every minute.

This chemically deforested area of the Amazon jungle was caused by illegal mining activities in the river basin of the Madre de Dios region in southeast Peru. Illegal mining has destroyed more than 11,000 hectares of Amazon rainforest. Cris Bouroncle/AFP

At the same time, we're pumping out a record volume of heat-trapping carbon dioxide into the atmosphere — 2.6 million pounds per second — from myriad sources, warming the planet as a whole. While some forests may benefit from more carbon dioxide in the air, others dry out, increasing risks of wildfires. Higher temperatures can also change rainfall patterns, leaving some trees vulnerable to drought or pests like bark beetles. In other words, climate change is a mixed bag for forests.

The world's forests have the potential to be carbon-devouring machines

It's important to remember that forests are not just trees. They are whole self-regulating ecosystems, from the soil bacteria that fix nitrogen to fertilize roots to the rodents and birds that spread seeds to the fungi that rot away carcasses and break down tree trunks.

All of these organisms working together allow forests to push moisture into the air and pull carbon into the ground. Nonetheless, trees are a useful proxy for the work that forests do, particularly with respect to climate change.

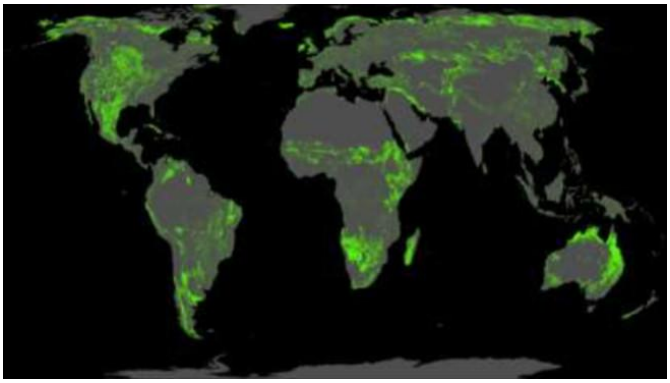
Trees are usually 50 percent carbon by weight and the vast majority of that comes from carbon dioxide absorbed from the air. A silver maple sapling, for example, would sequester 400 pounds of carbon dioxide over 25 years. That absorption can change based on the species of tree, its size, its age, its location, the soil its growing in, and the climate around it. Multiply that by the millions of trees across the world's woodlands, and you can get a sense of just how hard forests are working to keep our greenhouse gases in check.

Forests may also have other effects that can offset some of their carbon absorption. Dark leaves on trees can cause local temperatures to rise. Forests also emit aerosols, some of which have heat-trapping impacts, so reforestation does not necessarily lead to a straightforward reduction in global warming.

But Crowther and his colleagues also wanted to figure out how much carbon-sucking potential we've lost due to deforestation and how much we could get back by allowing forests spring back up — and planting them — in the places they once were.

There is distinction here between restoration, also known as reforestation, and afforestation. The latter refers to planting new trees where there were none before. The former refers to bringing trees back to areas that were previously forested, whether that's through planting trees or allowing the woodlands to regrow on their own.

Crowther and his colleagues used global satellite images to assess tree canopies, figuring out where forests are and where they could re-emerge. They found that there is 2.2 billion acres, or 0.9 billion hectares, worth of forest restoration potential. That's an area almost as big as the United States. Crowther hinted at these findings earlier this year and noted that this reforestation effort would amount to growing 1.2 trillion new trees across the planet.



This map shows potential forest restoration areas around the world. Science

From there, the scientists calculated the carbon removal potential of the newly restored forests. They concluded that the new forested areas would soak up an astounding two-thirds of humanity's emissions in the atmosphere since the 19th century.

However, Laura Duncanson, an assistant professor and a forest researcher at the University of Maryland who was not involved in the study, said this estimate presented in the paper is simplistic and doesn't take into account much of the regional variation that can influence a forest's capacity to absorb carbon. "I would take that as a very broad brush, back of the envelope-type potential carbon sink [calculation]," she said. "It's highlighting the potential of forests, but there's so much more research to do."

Forests are facing intense competition from industry and agriculture. That's why researchers are so keen to show their services to humanity.

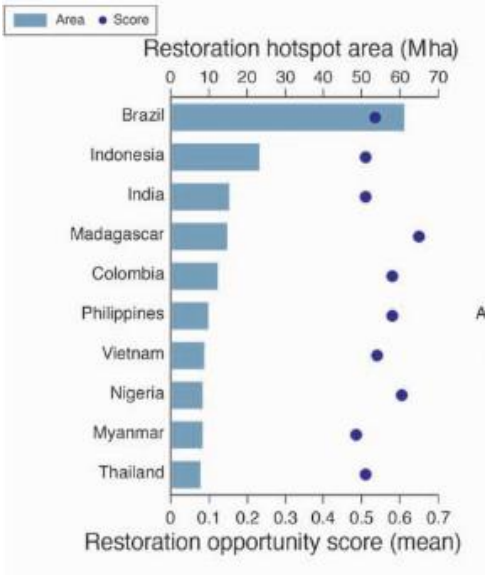
Another study out this week tries to offer more specific guidance on where we should be focusing reforestation efforts.

Robin Chazdon, a forest ecologist and an emeritus professor at the University of Connecticut, wanted to figure out which restored forests would deliver the most net benefits to humanity. Beyond mitigating climate change, trees help purify water, clean air, and provide homes to wildlife, so there's a lot to take into account.

In a paper published on Wednesday in the journal Science Advances, Chazdon and her collaborators came up with a scoring system for the world's forests to figure out where restoration would yield the greatest benefits.

They found that tropical rainforests — in countries like Brazil, Indonesia, India, Colombia, and Madagascar — in particular stood out. That's because these regions are home to a huge amount of biodiversity and play a major role in the planet's air and water cycle. Without these forests, these regions would see big changes in rainfall patterns, reductions in air quality, and the loss of some of the most unique species in the world.

Chazdon and her team then identified restoration hotspots, regions that scored in the top 10 percent in their evaluation. Put together, these hotspots span an area totaling 101 million hectares, about the size of Spain and Sweden put together, scattered around the world. What it shows, according to Chazdon, is that every part of the world has regions that would yield huge dividends from reforestation.



Most of the highest areas with the highest scores for restoration potential are in tropical rainforests. Science Advances

"Our sense is that these really good bets for restoration are found all over the world and many countries can participate in these activities," Chazdon said. "We did find some concentrations of these highest scores were distributed all over the tropics."

In particular, the highest average scores were in African countries like Rwanda, Burundi, and Uganda. "These countries, even though they might not have really large areas of tropical rainforest, the areas that they do have are very important restoration opportunities," she said.

However, many of these hotspots are already being used in other ways, like for farming and livestock grazing. Local demand for materials, land, and agriculture is often why these forests were cleared in the first place. That means a restoration program in these regions has to show that it delivers benefits that exceed the current uses of the land.

Looking at the carbon sequestration potential alone may not be enough to make that case, particularly since most countries don't have a mechanism that rewards taking in carbon dioxide emissions.

Forests' other valuable functions, like purifying water, mitigating air pollution, and drawing tourists also help make a strong policy case for restoring forests while creating pressure to deter further deforestation.

But Chazdon noted that it's hard to attach a price tag to every benefit we get from restoring forests, like increasing habitats for endangered species. A purely monetary calculation can backfire if the value of cutting down the forest suddenly increases. And many people who live on cleared forests subsist off their farming, so they need to be compensated and given alternative livelihoods if that land is going to be repurposed. So the biggest hurdle may be coming up with an economic system that benefits the environment while protecting the most vulnerable.

"To really make this work economically kind of requires a frameshift in the way we generate economies," Chazdon said. "The business as usual approach is what got us into this problem so to get out it is going to require some innovative mechanisms."

We need to prioritize forest restoration as a means to fight climate change, but we may be running out of time to do it

The Intergovernmental Panel on Climate Change warned last year that the world may have as little as 12 years left to limit warming this century to 1.5 degrees Celsius above pre-industrial levels. Keeping global emissions in line with that goal demands a full-court press across all sectors of society, from changing how we produce food to generating all of our power from clean sources.

But climate change isn't simply a function of how much greenhouse gases we emit; it depends on how we damage the things that take up carbon. That's why restoring forests stands to be a massive global opportunity to combat warming. The IPCC is now planning to release a special report this year focusing on land use, which will include forest management

Climate change in turn is starting to affect forests and their ability to store carbon. Crowther noted that warming is making some of the most carbon-absorbing forest areas less hospitable to their native species. Climate change-exacerbated weather extremes like torrential downpours can also damage forests. That means restoration efforts will have more climate benefits the sooner they are implemented and yield diminishing returns over time.

Duncanson, however, said that it's not clear what direction carbon absorption will go under climate change. While some regions may become less hospitable to trees, others may benefit from increasing carbon dioxide in the atmosphere, so extrapolating forest behavior from the present into the future may not make sense.

"We have a lot more certainty with how forests will respond to current growing conditions than in the future," Duncanson said. "They might be more robust than we think. They might be even better carbon sinkers in the future. We don't know."

Also, not every bit of land that can be reforested will be reforested because there are other constraints. Even if a government were inclined to restore a forest, there is a finite amount of money, resources, and political capital to do so. So despite the theoretical potential of countering two-thirds of man-made emissions, it will be breathtakingly hard.

Duncanson said that Chazdon's and Crowther's papers both stand out for getting specific in identifying regions where trees could regrow. "It's nice to see that we have gone to the point of actually having maps of areas to restore forests," she said.

She is working on a project, known as the Global Ecosystem Dynamics Investigation (GEDI), that uses LIDAR aboard the International Space Station to create a three-dimensional map of the world's forests. From there, researchers hope to get a far more accurate estimate of the how trees take in carbon dioxide and what that means for the global climate. "I think that will be a nice extension of this work," Duncanson said.

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