

Tropical forest restoration is a global, high-value opportunity

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Forests cover 31 percent of global land, and deforestation is a major issue in tropical rain forests because they are home to much of the world's biodiversity.

The green belt of tropical rainforests that covers equatorial regions of the Americas, Africa, Indonesia and Southeast Asia is turning brown. Since 1990, Indonesia has lost 50 percent of its original forest, the Amazon 30 percent and Central Africa 14 percent. Fires, logging, hunting, road building and fragmentation have heavily damaged more than 30 percent of those that remain.

These forests provide many benefits: They store large amounts of carbon; are home to numerous wild species; provide food and fuel for local people; purify water supplies; and improve air quality. Replenishing them is an urgent global imperative. A newly published study in the journal *Science* by European authors finds that there is room for an extra 3.4 million square miles of canopy cover around the world, and that replenishing tree cover at this full potential would contribute significantly to reducing the risk of harmful climate change.

But there aren't enough resources to restore all tropical forests that have been lost or damaged. And restoration can conflict with other activities, such as farming and forestry. As a tropical forest ecologist, I am interested in developing better tools for assessing where these efforts will be most cost-effective and beneficial.

Over the past four years, tropical forestry professor Pedro Brancalion and I have led a team of researchers from an international network in evaluating the benefits and feasibility of restoration across tropical rainforests around the world. Our newly published findings identify restoration hotspots — areas where restoring tropical forests would be most beneficial and least costly and risky. They cover over 385,000 square miles, an area as large as Spain and Sweden combined.

The five countries with the largest areas of restoration hotspots are Brazil, Indonesia, India, Madagascar and Colombia. Six countries in Africa — Rwanda, Uganda, Burundi, Togo, South Sudan

and Madagascar — hold rainforest areas where restoration is expected to yield the highest benefits with the highest feasibility. We hope our results can help governments, conservation groups and international funders target areas where there is high potential for success.



Native tree nursery for large-scale restoration of Atlantic Forest at Reserva Natural Guapiaçu, Rio de Janeiro State, Brazil.

Where to start

Intact forest landscapes in tropical regions declined by 7.2 percent from 2000 to 2013, mainly due to logging, clearing and fires. These losses have dire consequences for global biodiversity, climate change and forest-dependent peoples.

As my work has shown, tropical forests can recover after they have been cleared or damaged. Although these second-growth forests will never perfectly replace the older forests that have been lost, planting carefully selected trees and assisting natural recovery processes can restore many of their former properties and functions.

But restoration is not uniformly feasible or desirable, and the benefits that forests provide are not evenly distributed. To make informed choices about restoration efforts and investments, organizations need more detailed spatial information. Existing global maps of restoration opportunities are based on actual versus potential levels of tree canopy cover. We wanted to go beyond this measurement to identify where the greatest potential payoffs and challenges lay.

Our study used high-resolution satellite imagery and the latest peer-reviewed research to integrate information about four benefits from forest restoration: biodiversity conservation; climate change

mitigation; climate change adaptation; and water security. We also assessed three aspects of feasibility: cost; investment risk; and the likelihood of restored forests surviving into the future.

We studied these variables across all lowland tropical moist forests worldwide, dividing them into 1-kilometer square blocks that had lost more than 10 percent of their tree canopy cover in 2016. Each of the seven factors we studied had equal weight in our calculation of total restoration opportunity scores.

The top-scoring blocks, which we call "restoration hotspots," represent the most compelling regions for tropical forest restoration, with maximum overall benefits and minimal negative trade-offs.

Forest restoration aligns with other global pledges

The top 15 countries with the largest areas of restoration hotspots are distributed across all tropical rainforest regions around the world. Three are in Central and South America, five are in Africa and the Middle East and seven are in Asia and the Pacific.

Importantly, 89 percent of the hotspots we identified were within areas already identified as biodiversity conservation hotspots (PDF) in tropical regions. These conservation hotspots have exceptionally high concentrations of at-risk species. They have been focal areas for investment and activities to promote biodiversity conservation for nearly 20 years.

This finding makes sense, as two criteria for designating conservation hotspots — high rates of forest loss and high concentration of endemic, or locally distributed, species — also were variables in our study. Our results strongly support the need to develop and implement integrated solutions that protect remaining forest ecosystems and restore new forests within these high-priority regions.

We also found that 73 percent of tropical forest restoration hotspots are in countries that have made commitments under the Bonn Challenge, a global effort to bring some 580,000 square miles of the world's deforested and damaged land into restoration by 2020, and 1.35 million square miles by 2030. By making these pledges, Bonn Challenge participants have shown that they are politically motivated to restore and conserve forests, and are looking for restoration opportunities.

A means toward many ends

The 88 percent of the lands we analyzed that did not qualify as restoration hotspots also deserve careful attention. These landscapes could be prioritized for restoration interventions that increase food, water and fuel security through agroforestry practices, watershed protection, woodlots for producing firewood and local timber or commercial tree plantations. All of these areas can provide benefits for people and the environment through combinations of different restoration approaches, even if they are not the best candidates for a full-scale effort to restore a high-functioning forest.

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Forest restoration on small farms bordering Mpanga Forest Reserve, Uganda, can bring high levels of benefits and is relatively feasible to achieve.

Forest restoration is also urgently needed in other types of forests across the world, such as seasonally dry tropical forests and temperate forests that are heavily managed for timber. Identifying key restoration opportunities in these regions requires separate studies based on their unique benefits and challenges.

Our study helps to highlight how restoring tropical forests can provide multiple benefits for people and nature, and aligns with existing conservation and sustainable development agendas, as discussed in a newly published perspective related to the new findings in Science. We hope that our map of restoration opportunities and hotspots will provide useful guidance for nations, conservation organizations and funders, and that local communities and organizations will be engaged in and benefit from these efforts.

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