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Summary of key points

- We have lost more than half of the world's forested land, and only 3% of the world's ecosystems remain intact. This has driven significant losses to natural carbon storage, biodiversity, and human well-being.
- Global forest restoration has the potential to capture up to 30% of our existing carbon emissions, once forests have reached full maturity.
- Restoration is not a silver bullet. It is one of the myriad of solutions required to limit carbon emissions and to draw down atmospheric carbon. But when done right, restoration can play a critical role in the fight against biodiversity loss and climate change, which will improve human well-being.
- Restoration is not an easy way out. Forest recovery cannot be achieved by mass plantations or monocultures. Restoration is not just the planting of new trees but creating conditions that allow forests to recover naturally.
- The key to effective and sustainable restoration is finding the innovations that make nature an economically viable option for local communities.

The current situation

Natural ecosystems are the foundation of all life on Earth, including our own. From forests to prairies to wetlands, diverse and abundant ecosystems clean our air, filter our water, feed our livestock, and fertilize our crops.

In addition, these ecosystems capture and store massive amounts of carbon.

Terrestrial ecosystems naturally emit about 120 Gigatons of carbon each year. Before the industrial revolution, these carbon emissions from terrestrial ecosystems were balanced by the amount they absorbed each year. The balanced system created the climate conditions that we are adapted to.

As a result of burning fossil fuels and clearing forests for agricultural land, humans now emit about 10 Gigatons of carbon each year. Although this is less than the natural carbon fluxes, these human emissions are not being counterbalanced by any uptake, which causes atmospheric carbon concentrations to rise. This imbalance is warming the climate.

At the same time, deforestation and environmental degradation limits the capacity of natural forests to absorb carbon, creating a vicious cycle. Since the beginning of agriculture 12,000 years ago, the world's forest cover has decreased by around 50 percent[1], and only 3 percent of the remaining forests are still intact.[2] In the contiguous United States, just 6-7 percent of forests remain intact, with the majority of those undisturbed forests existing in the West.[3]

As a result of global deforestation and land clearing, the carbon pool in the world's forests has been depleted by hundreds of billions of tons.[4]

Yet forests are one of the most effective ways to capture and store carbon. They play a central role in regulating the carbon cycle. As they grow, trees absorb carbon dioxide

through their leaves and convert it into wood. Over their lifespan, which can be decades or even hundreds of years, trees continuously absorb and store carbon, and they release much of it into the soil, where it can stay for hundreds or even thousands of years.

The potential of forests

Preventing the loss of forest ecosystems is absolutely necessary to limit future carbon emissions. In addition, the restoration of degraded ecosystems can contribute to the capture (or drawdown) of carbon that has already been released into the atmosphere. There is a growing scientific consensus that these actions have the power to change the current climate trajectory to avoid worst-case scenarios.[5]

Our research suggests that, outside of urban and agricultural areas, there are 2.2 billion acres (0.9 billion hectares) of degraded land worldwide where trees would naturally exist.

If these natural ecosystems were restored, we estimated this would create room for the natural re-growth of just over 1 trillion new trees globally.[6] If we can protect these ecosystems over the rest of the century, the regenerating forests could capture up to 30% of the excess carbon that has been emitted by human activity to-date.

Of course, this carbon capture would not be immediate. Only when these ecosystems reach full maturity would they reach the maximum carbon storage potential. However, corresponding increases in evapotranspiration can contribute to the production of clouds in tropical regions, which can have an immediate cooling impact.

It has often been proposed that once a tree dies and decomposes, all of the carbon it stored during its life is released again into the atmosphere. This would suggest that forest restoration is not a long-term carbon storage solution. However, this is a common misunderstanding that comes from the focus on carbon fluxes rather than carbon pools. The fluxes of carbon change all the time as a result of tree photosynthesis, respiration, death, decomposition, and growth. But as long as the entire ecosystem continues to develop, the carbon in the vegetation and soil will continue to accumulate. It is only when forests reach their climax state that they stop accumulating carbon. But that is generally the maximum carbon storage state of the ecosystem, and once that state is reached, the accumulated carbon will remain there for as long as the ecosystem survives.

The nuance

Despite the considerable potential of forest restoration to capture carbon, it also comes with considerable risks. It is essential to remember that the restoration of trees is not a silver bullet against climate change. Addressing carbon emissions will require a multitude of technological, societal, and nature-based solutions to limit carbon emissions and draw carbon from the atmosphere.

It is tempting to think that we can plant some trees and ignore the challenges of cutting emissions and protecting existing ecosystems. However, when viewed through this lense, tree restoration would only have damaging consequences for the climate movement.

In addition, this perspective of forests as an easy way out is also a threat to the ecosystems that remain on the planet. Mass plantations of monocultures - forests that are composed of a single species - have become widespread attempts to capture carbon. It has been estimated that 45% of “restored” forests around the world are such monoculture plantations, which are devastating to local biodiversity and ecosystem health. In turn, these losses are damaging to human well-being.

Monoculture plantations lack the thousands of interacting species (including plants, animals, and microorganisms) that are necessary to maintain a healthy ecosystem. As such, these ecosystems are not resilient, as all individuals are susceptible to the same threats. In addition, all individuals within monoculture forests are competing with one another for exactly the same resources, which means the trees are limited in their capacity to store carbon.

Ultimately, the restoration of global forests cannot be achieved by “planting” a trillion trees. In the majority of cases, it is better to protect land and let forests recover naturally, promoting healthy levels of biodiversity.

But in some cases, global restoration will also include the planting and management of trees in diverse mixtures to promote human well-being and economic sustainability.

The challenge

Tree restoration is not as easy as just planting trees. Indeed, it is not easy at all. To be successful in the long term, restoration efforts require an intricate understanding of the local ecology, as well as the social and economic context of local communities.

Whether trees are allowed to regenerate naturally or planted to facilitate ecosystem recovery, it is critical to get the right trees in the right places.

But by far the biggest challenges are the social and economic challenges.

If nature is not as profitable as other land use options available to people, it follows that those ecosystems will not survive in the long term. Forest restoration cannot come at the expense of local people. Instead, local communities must benefit economically from the health of their natural environment.

There are countless examples across the world where the protection and revitalization of nature enhances the well-being and economic sustainability of local communities. These opportunities exist in every region across the globe, ranging from the protection of forests to improve soil fertility for adjacent crops, to the sustainable harvesting of timber, to the sale of carbon credits from naturally regenerating forests.

In any forested region on Earth, the key innovations that are critical to successful restoration are those that make nature the economically sustainable option for local communities. Only when we identify the economic benefits of nature do we see the long-term recovery and protection of ecosystems.

And the integration of nature is equally important within agricultural areas. When native shade trees increase the yields of cocoa plantations, then local farmers are incentivised to integrate more trees into their systems. If they can then sell the carbon credits to gain additional benefits, there will be further incentives to promote nature. Finding these solutions in every location around the world is the key to the success of the trillion tree campaign.

The restoration of nature is not inherently a global challenge. It is a local challenge for the local biodiversity and the people that depend on it. It is only as the network of collective action grows that it benefits everyone with carbon capture at a global scale. Incentivising thousands of local communities to protect and revitalize nature can have tangible impacts on biodiversity, climate change, and human well-being everywhere.

The trillion trees movement is not about planting a trillion trees. It is about creating a world where a trillion trees can naturally recover to support thriving human populations across the globe.

Notes:

[1] Crowther, T., Glick, H., Covey, K. et al. Mapping tree density at a global scale. Nature 525, 201–205 (2015). https://doi.org/10.1038/nature14967

[2] Plumptre, A., Baisero, D., Belote RT. et al. Where Might We Find Biologically Intact Communities? Frontiers in Forests and Global Change 4, 26pp (2021). https://doi.org/10.3389/ffgc.2021.626635

[3] Moomaw, W., Masino, S., Faison E. Intact Forests in the United States: Proforestation Mitigates Climate Change and Serves the Greatest Good. Frontiers in Forests and Global Change 2, 27pp (2019). https://doi.org/10.3389/ffgc.2019.00027

[4] Erb, KH., Kastner, T., Plutzar, C. et al. Unexpectedly large impact of forest management and grazing on global vegetation biomass. Nature 553, 73–76 (2018). https://doi.org/10.1038/nature25138

[5] Intergovernmental Panel on Climate Change (IPCC). An IPCC Special Report on the Impacts of Global Warming of 1.5 °C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways. IPCC (2018). https://www.ipcc.ch/sr15/

[6] Bastin, JF., Finegold, Y., Garcia, C. et al. The global tree restoration potential. Science 365, 76-79 (2019). https://doi.org/10.1126/science.aax0848