

Assessing the benefits and risks of land-based greenhouse gas removal

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IIASA researchers collaborated with colleagues at a number of international institutions to assess the benefits and risks associated with six different land-based greenhouse gas removal options in light of their

potential impacts on ecosystems services and the UN Sustainable Development Goals.

The Paris Agreement calls for [global warming](#) to be limited to well below 2°C above pre-industrial levels and for greenhouse gas (GHG) emission neutrality to be achieved by the second half of the century. Even before the Agreement came into force, scientific analysis demonstrated the extreme difficulty of achieving these goals by mitigation alone. Research on the subject in fact highlighted that to achieve GHG neutrality, the emissions caused by human activities would have to be balanced by the removal of carbon dioxide (CO₂) from the atmosphere to compensate for the inadequacy of currently planned mitigation measures.

Some existing options for land-based GHG removal include afforestation (establishing new forests) or reforestation (replanting previously forested areas with trees), wetland restoration, [soil carbon sequestration](#), biochar (charcoal used as a soil amendment), terrestrial enhanced weathering (dissolution of minerals to remove CO₂ from the atmosphere), and bioenergy with carbon capture and storage (BECCS).

IIASA researchers contributed to a study in which the risks associated with these six land-based GHG removal options were assessed in light of their potential impacts on ecosystems services. In this regard, the team specifically looked at impacts in terms of Nature's Contributions to People (NCPs) - among which the most valuable and visible benefits are probably plentiful food, and clean air and water—and the UN Sustainable Development Goals (SDGs).

The results, which were published in the *Annual Review of Environment and Resources*, indicates that all land-based GHG removal options contribute positively to at least some NCPs and SDGs. Wetland restoration and soil carbon sequestration, for instance, almost exclusively

deliver positive impacts and could thus be taken up immediately. The four other options, however, require [risk management](#) to avoid negative impacts on NCPs and SDGs such as increased competition for available land that could in turn lead to bottlenecks in food production.

"For options that present specific risks at scale or those that are not as well understood, more research is required and demonstration projects need to proceed with caution. For options that present low risks and provide cobenefits, implementation can proceed more rapidly following no-regrets principles," explains study coauthor Florian Kraxner, Head of the IIASA Center for Landscape Resilience and Management and deputy director of the institute's Ecosystems Services and Management Program.

According to the researchers, managing the risks associated with these options could involve excluding some CO₂ removal options from certain regions, areas, or environments.

"Afforestation and other forms of climate-friendly land use can do more than just extract many gigatons of CO₂ from the atmosphere and thereby reduce global warming. When sensibly applied, they can also contribute to achieving the SDGs as defined by the UN, like reducing hunger and poverty," Kraxner concludes.

More information: Pete Smith et al, Land-Management Options for Greenhouse Gas Removal and Their Impacts on Ecosystem Services and the Sustainable Development Goals, *Annual Review of Environment and Resources* (2019). [DOI: 10.1146/annurev-environ-101718-033129](https://doi.org/10.1146/annurev-environ-101718-033129)

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