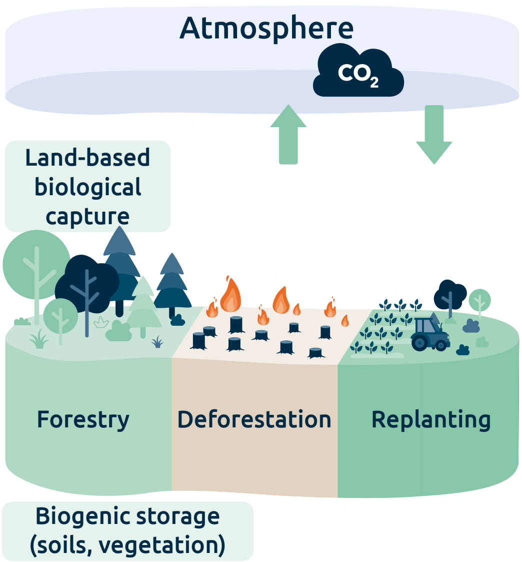
Afforestation and Reforestation

NEGEM

A practice which enhances natural carbon stores and can reduce emissions



Expected permanence	decades-centuries
Reversal risk	high
Uncertainty in amount of initially captured carbon	medium
Uncertainty in amount of carbon stored over time	high
Ease of MRV	low
Key benefits	Can enhance biodiversity, ecosystem function

What is afforestation and reforestation and how does it store carbon?

Afforestation (A) involves planting new trees and increasing forest cover in previously non-forested lands, whereas reforestation (R) refers to replanting trees on recently deforested or degraded land. Forests act as carbon sinks as they remove CO_2 from the atmosphere via photosynthesis and store it in living biomass, dead organic matter, and forest soils. Carbon can accumulate in the stem and branches (above-ground biomass) but also in the roots (below-ground biomass) and soil. Continuous management of forest biomass is necessary to retain carbon in the vegetation and soils, hence this storage type is vulnerable to leakage and therefore likely to be temporary. Afforestation and reforestation practices that prioritise native mixed species, instead of non-native monoculture plantations, provide extra ecosystem functions and boost biodiversity.

Current annual rates of carbon storage from land-based conventional CDR (includes afforestation, reforestation and existing forest management) are estimated at 2 Gt CO_2 according to the State of CDR report from 2023.

Relevant regulatory frameworks: EU LULUCF regulation, Nature Restoration Law, proposal for a Monitoring framework for resilient European forests. Society has agreed to several biodiversity and ecosystem restoration targets as set out in the Kunming-Montreal Global Biodiversity Framework and the Bonn Challenge.

ADVANTAGES

MULTIPLE CO-BENEFITS
Reforestation has extensive co-benefits. It contributes to nature restoration, soil health, biodiversity, biosphere integrity and climate stabilisation.

LOW COST
Afforestation and reforestation already occur and is cheaper to implement than other NETPs. Little additional infrastructure is required.

POSITIVE PUBLIC PERCEPTION
Generally afforestation and reforestation are perceived well by the public.

ECONOMIC BENEFITS
Projects can empower and provide economic benefits to local communities.

CHALLENGES

HIGH LEAKAGE RISK
Carbon stored in forest vegetation is vulnerable to disturbances such as wildfires, pests and disease, as well as land ownership change, where forests may be lost.

HARD TO QUANTIFY STORED CARBON
Carbon stored below ground carbon is hard to measure. Geographical location affects capacity to sequester carbon and the associated climate feedbacks (e.g. albedo, evapotranspiration).

LIMITS ON STORAGE CAPACITY
Sequestration rate and forest growth is slow. Eventually, forests saturate, and therefore release as much CO_2 (e.g. from trees dying, for instance) as they absorb.

LOCAL COMMUNITY RIGHTS
Projects may not always prioritise the rights of local and marginalised communities, which are often excluded from decision-making processes.

ADDITIONAL LAND REQUIRED
Afforestation on previously non-forested land can lead to extensive land use change, exacerbating food insecurity, land conflict, and add pressure on planetary boundaries.

ADVERSE ENVIRONMENTAL IMPACTS
Afforestation projects on previously non-forested land can demand significant fertilisation and irrigation inputs. Projects can also involve the introduction of non-native species.

What is the sustainable potential of afforestation or reforestation to sequester carbon?

Economic performance

CapEx
Costs for roads and irrigation systems vary depending on the scale and location of the project. Potential increases in land prices will drive up costs.

OpEx
Sustained but low costs for continuous forest and land management.

Environmental performance

Depends on vegetation type and species diversity, fertiliser use and irrigation needs. Potential for beneficial land-use change, improved biosphere integrity, freshwater impacts- and nutrient flows under reforestation using diverse and native species. Afforestation with plantations may lead to loss of biodiversity.

Estimated scale and cost (2050)

0.5-10 $GtCO_2$/yr
$0-240/$tCO_2$

Resource security

Substantial additional land area will be required for afforestation projects. Reforestation will also require land conversion, given that the majority of agricultural areas were established on previously forested land.

Social and governance performance

A/R carries popular public support due to expected positive consequences for nature and future generations.

Risk of reversal is strongly linked to land use and management policies.

Current unknowns and future research perspectives

It is not clear to what extent A/R is compatible with other land-based NETPs, considering economic, political, and social pressures on land area for food and urban development.

Climate feedbacks from the emissions of non-carbon dioxide greenhouse gases, volatile organic compounds, evapotranspiration and albedo changes can counterbalance the climate mitigation from the reduction in atmospheric CO_2 concentrations. These impacts need more accurate quantification to clarify the net climate benefit.

It is unclear what the continued impact of climate change will have on the ability for forests to grow, survive and store carbon, further complicating accounting, MRV and overall CDR efficiency.

Policy recommendations

- Align climate and nature restoration regulation to achieve better, more coherent environment policy.
- End deforestation, protect old forests, ban illegal and intensive logging, reduce commercial plantations, and avoid harvests for short-term uses (such as for bioenergy, pulp and paper); ensure that the amount of harvested biomass does not exceed the capacity for forests to grow biomass to replace the losses.
- Adopt close-to-nature forestry management and other sustainable practices including planting mixed, native species and promoting old-forest growth; continue forest management after saturation to prevent disturbances from releasing sequestered carbon.
- Implement a large-scale food system transformation, in line with the EAT-Lancet planetary health diet to free up land, contribute to forest restoration, and to avoid conflicts with food production and security; prioritise reforesting and restoring degraded and desertified lands in primary and secondary forests.
- Take into account trade-offs (biosphere integrity, land use change, ecosystems, water cycle), local conditions, climate conditions, and climate feedbacks (surface albedo or evapotranspiration processes) in A/R projects.
- Adopt a rights-based approach that respects land rights of local and indigenous communities.

Relevant literature

The Land Gap Report, update 2023
IPCC Special Report on Climate Change and Land, 2019
NEGEM Deliverables: D1.2, D2.2, D3.2, D3.3, D3.6, D3.7, D3.8, D3.10, D4.5, D5.5, D7.2

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