Bioeconomy 2.0 Q&A

What role do forests play in the global carbon cycle?

Forests remove CO_2 from the atmosphere through photosynthesis and store carbon in tree stems, branches, foliage and roots). Part of this carbon is transferred into soils through litterfall (such as dead plant material that has fallen to the ground) or tree mortality, returning the CO_2 eventually to the atmosphere via decomposition. Harvest of wood can lead to stems and sometimes also other tree parts, such as branches and tree tops, being removed from the forest, and used for wood products and energy. When wood is used for long-lived products, the carbon is stored (e.g., in buildings) for decades or even centuries, until the end of the product life. If wood is used for energy, its carbon is returned to the atmosphere through combustion. Additionally, when wood is used to substitute a product made from a non-renewable material (e.g., concrete, steel, plastics), the use of wood can avoid emissions.

What affects the carbon balance, i.e. whether the forest system is a sink or a source?

The carbon stored in forest biomass (above- and below-ground), deadwood, litter, soil organic carbon and wood products represents the carbon stocks. If more carbon is stored than released (through decomposition or combustion), the forest system acts as a carbon sink. Conversely, when more carbon is released than stored, the system acts as a source of carbon. The balance between uptake and release of CO_2 is affected by many factors. The ability to take up CO_2 depends on environmental conditions such as water and nutrient availability, as well as age. Forests generally grow faster when they are young, and growth slows down as trees get older. Multiple measures such as improved forest management and silvicultural practices, afforestation, reforestation and reduced deforestation affect *carbon sequestration* (the capturing and storing of atmospheric CO_2) in forest ecosystems.

What happens if we harvest more trees?

The carbon balance of forests is affected by the harvesting intensity. Increased harvesting of trees generally reduces carbon storage in forest biomass. However, in the absence of disturbances, carbon sequestration could recover after new trees grow. This initial decrease in forest carbon caused by harvest may lead to a temporary increase in atmospheric carbon concentrations - unless this amount is balanced by the benefits obtained from using wood products through storage and substitution effects.

What benefits do wood products provide?

Wood products not only store carbon but can also substitute non-renewable and emissions-intensive materials, for example in construction or for producing textile fibres.

Usually wood and wood-based products have lower fossil and process-based greenhouse gas emissions when compared to non-wood materials. The overall substitution benefits depend not only on the relative difference in emissions between two alternative products, but also on the scale of production and consumption of products. To maximize substitution benefits, it is important to focus on substituting fossil-intensive products or fossil energy sectors that cannot move quickly towards greenhouse gas reduction, and sectors with large, unexploited market potentials for wood-based products like textiles, plastics and construction. However, this situation is not static - technological change could reduce the emission intensity of competing products in future.

How does Climate Smart Forestry work?

Climate Smart Forestry is a holistic approach to sustainable forest management. It aims to increase carbon storage in forests and wood products (in conjunction with the provisioning of other ecosystem services), enhance forest health and resilience through adaptive forest management, and use wood resources sustainably to substitute non-renewable, carbon-intensive materials. The choice of forest management options varies by location, considering the significantly varying regional circumstances across the globe.

What could maximise the contribution of forestry and the forest sector to mitigating climate change?

Our study shows that this would be maximised by:

- *Taking a holistic approach that considers carbon storage in forest biomass, soil and wood products, substitution effects, as well as potential leakage effects.* Sustainable, climate-smart forest management must ensure the current and future supply of raw materials, protect and improve biodiversity, and preserve soil and water quality, for a balanced contribution to all ecological, economic and social functions.
- *Strengthening forest carbon sequestration in managed forests by stimulating forest productivity* (e.g., tree species and provenance selection, thinning and harvest regimes) *and by strengthening the resilience of forests to climate change* (e.g., by increasing species diversity). This should be achieved by sustainable forest management practices that are locally relevant and which consider future climate conditions.
- *Policymakers and forest managers considering carbon storage both in the short and long term.* Reducing wood harvest increases carbon storage in forest ecosystems in the short term, and may bring benefits to biodiversity, soil and water quality. However, it may compromise economic benefits from forests, and the increase of carbon storage is valid until the forest carbon sink saturates. Forest management should also consider that natural disturbances such as storms, wildfires and pests are expected to increase under climate change conditions, having immediate economic impact on wood applications and eventually leading to carbon release to the atmosphere.
- *Following the principles of cascade use for the sustainable use of wood for materials and products*. In this approach wood is used, reused and recycled, thereby extending the material's lifetime within the system. In addition, wood should be used for products that store carbon for as long as possible, and for products that provide large substitution benefits by avoiding emissions.
- *Forest-based bioenergy has a role in the transition of the energy sector towards emissions-free energy production.* When using woody biomass for energy purposes, preference should be given to post-consumer wood and forest residues that are not suitable for the production of other materials and which do not lead to additional harvest.

More information

Blasius Schmid, Fredric Mosley, Mariana Hassegawa, Pekka Leskinen and Pieter Johannes Verkerk. 2021. Forest-based bioeconomy and climate change mitigation. European Forest Institute.

The *Bioeconomy 2.0 - Bio resources in the transition to net-zero EU GHG emissions* project has been carried out by the European Forest Institute in collaboration with Material Economics. Financial support has been provided by the Finnish Innovation Fund Sitra.
https://efi.int/projects/bio-economy-20-bio-resources-transition-net-zero-eu-ghg-emissions