Swamp forests are important long term carbon stores

Most of the atmospheric carbon trapped by growing forests becomes a short term carbon store in live trees. Some of this carbon moves to a longer lasting store in the forest soils. In swamp forest soils, this carbon store is permanent and continues to accumulate for thousands of years. In the struggle to solve the carbon capture and storage challenge, we can take advantage of nature's capacity to do so.

Swamp forests have higher soil carbon stores than drier forests because the wet ground prevents decomposition of organic matter.

Use or store forest carbon?

Mitigating climate change means to reduce sources or enhance the sinks of greenhouse gases. Forests can be managed to support both of these alternatives, but not at the same time. The forestry sector argues for harvesting more wood to substitute products that cause fossil carbon emissions. Nature conservationists often argue that it is important to maintain and increase the forests carbon stores because forests capture CO_2 from the atmosphere.

Both sides have valid arguments and the International Panel on Climate Change (IPCC) states, based on thorough analysis of scientific evidence, that the forestry sector provides important opportunities for mitigating climate change. These opportunities include substitution of fossil fuels and increasing carbon stocks by sequestration in trees and soils, as well as other options. The IPCC does not give specific recommendations, however, and countries need to decide themselves which options to use.

In this context it is important to consider that forests differ in their ability to store carbon.

Why some forests store much carbon

The forest soils store much more carbon than the living trees. In boreal forest, the amount of carbon is 3-4 times higher in the soil as in all trees and the ground vegetation. Behind this main picture there are substantial differences across forest types, and the highest concentration of soil carbon occurs in wet swamp forests. This might be surprising since swamp forests are not capturing equally much CO_2 from the atmosphere per year as more productive forests on well-drained soils.

The decomposition process is the key to understand this. Forests on well-drained soils typically have larger standing volume and higher production of dead organic material (leaves, needles and woody material). But the decomposition rate of the organic material is also high, both on the forest ground and in the soils where the decomposition continues.

In swamp forest soils, the decomposition process stops almost completely due to the permanently wet conditions and lack of oxygen. The preserving environment in the wet soil has conserved whole pieces of stumps and trees for several thousand years. In Norwegian alpine peat, one has found dead trees from forest that existed here 8000 years ago when the tree line

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was higher than today. Likewise, peat excavation in southern Sweden and Northern Germany has exposed almost intact trees that died 5000-7000 years ago. Thus, the conservation in water-saturated soil occurs under all climate conditions. Also finer organic material is conserved as evidenced from samples taken several metres down at the bottom of peat bogs. Here we find 10 000 years old peat that started to accumulate after the end of the last glaciation. From Finnish studies we also know that the soil carbon accumulation rate is higher in forested peatland than in open peatland.

In summary, we have solid knowledge that wet swamp forest soil accumulates more carbon than well drained soils. Furthermore, we know that this store continue to grow for millennia as long as the soil remains permanently wet.

Differential land use

Moving back to the opening question of this article – should we utilize or store the forest carbon? It is very likely that both options will be used when countries develop policies to mitigate climate change. In this policy field one should consider that forest types different in their ability to build up a long-lasting carbon store.

Most of the boreal forests in the Nordic countries occur on well-drained soil and these forests are generally more productive than swamp forests. But they do not build up as large soil carbon stores as the swamp forests do. Hence, they are more suitable for harvesting wood to substitute fossil carbon.

Swamp forests in the south, but they are are more common in the mid boreal and north boreal zones. Here they represent 10-30 % of the productive forests area. These low-productive swamp forests have large soil carbon stores that will continue to grow if the forests are not harvested. Instead, they will continue to capture CO_2 from the atmosphere and add organic matter to a growing soil carbon store.

From a climate change mitigation perspective it is reasonable to put more emphasis on harvesting of forests on well-drained soils and more emphasis on carbon storage in forests on poorly drained soils.

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