Old-growth forest carbon sinks overestimated

March 25 2021

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The claim that old-growth forests play a significant role in climate mitigation, based upon the argument that even the oldest forests keep sucking CO_2 out of the atmosphere, is being refuted by researchers at

the University of Copenhagen. The researchers document that this argument is based upon incorrectly analyzed data and that the climate mitigation effect of old and unmanaged forests has been greatly overestimated. Nevertheless, they reassert the importance of old-growth forest for biodiversity.

Old and unmanaged forest has become the subject of much debate in recent years, both in Denmark and internationally. In Denmark, setting aside forests as unmanaged has often been argued to play a significant role for climate mitigation. The argument doesn't stand up according to researchers at the University of Copenhagen, whose documentation has just been published as a commentary in *Nature*.

The entire climate mitigation argument is based upon a widely cited 2008 research article which reports that old-growth forests continue to suck up and sequester large amounts of CO_2 from the atmosphere, regardless of whether their trees are 200 years old or older. UCPH researchers scrutinized the article by reanalysing the data upon which it was based. They conclude that the article arrives at a highly overestimated climate effect for which the authors' data presents no evidence.

"The climate mitigation effect of unmanaged forests with trees more than 200 years old is estimated to be at least one-third too high—and is based solely upon their own data, which, incidentally, is subject to great uncertainty. Thus, the basis for the article's conclusions is very problematic," explains Per Gundersen, of the University of Copenhagen's Department of Geosciences and Natural Resource Management.

An unlikely amount of nitrogen

The original research article concluded that old-growth forests more than

200 years old bind an average of 2.4 tons of carbon per hectare, per year, and that 1.3 tons of this amount is bound in forest soil. According to the UCPH researchers, this claim is particularly unrealistic. Carbon storage in soil requires the addition of a certain amount of externally sourced nitrogen.

"The large amounts of nitrogen needed for their numbers to stand up don't exist in the areas of forest which they studied. The rate is equivalent to the soil's carbon content doubling in 100 years, which is also unlikely, as it has taken 10,000 years to build up the soil's current carbon content. It simply isn't possible to bind such large quantities of carbon in soil," says Gundersen.

Trees don't grow into the sky

Unlike the authors of the 2008 article, and in line with the classical view in this area, the UCPH researchers believe that old unmanaged forests reach a saturation point after a number of years. At that point, CO_2 uptake ceases. After longer periods (50-100 years in Denmark) of high CO_2 sequestration, storage decreases and eventually come to a stop. This happens when a forest reaches an equilibrium, whereby, through the respiration of trees and degradation of organic matter in the soil, it emits as much CO_2 into the atmosphere as it absorbs through photosynthesis.

"As we know, trees don't just grow into the sky. Trees age. And at some point, they die. When that happens, decay begins, sending carbon back into the atmosphere as CO_2. Other smaller trees will then take over, thereby leaving a fairly stable CO_2 stock in the forest. As trees age, the risk of a forest being impacted by storms, fire, droughts, disease, death and other events increases more and more. This releases a significant portion of the stored carbon for a period of time, until newer trees replace the old ones," explains Gundersen. He adds that the 2008 article does not document any mechanism which allows the forest to keep

sequestering CO_2.

The UCPH researchers' view is supported by observations from Suserup Forest, near Sorø, Denmark, a forest that has remained largely untouched for the past century. The oldest trees within it are 300 years old. Inventories taken in 1992, 2002 and 2012 all demonstrated that there was no significant CO_2 uptake by the forest.

Old-growth forest remains vital for biodiversity

"We feel a bit like the child in the Emperor's New Clothes, because what we say is based on classic scientific knowledge, thermodynamics and common sense. Nevertheless, many have embraced an alternative view—and brought the debate to a dead end. I hope that our contribution provides an exit," says Per Gundersen.

He would like to make it clear that this should in no way be perceived as a position against protection of old-growth forest or setting aside unmanaged forest areas.

"Old-growth forest plays a key role in biodiversity. However, from a long-term climate mitigation perspective, it isn't an effective tool. Grasping the nuance is important so that debate can be based upon scientifically substantiated assertions, and so that policy is not influenced on an incorrect basis," concludes Gundersen.

More information: Per Gundersen et al. Old-growth forest carbon sinks overestimated, *Nature* (2021). DOI: 10.1038/s41586-021-03266-z

Provided by University of Copenhagen