Living in timber cities could avoid emissions, without using farmland for wood production

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Housing a growing population in homes made out of wood instead of conventional steel and concrete could avoid more than 100 billion tons of emissions of the greenhouse gas CO_2 until 2100, a new study by the Potsdam Institute for Climate Impact Research shows. These are about

10% of the remaining carbon budget for the 2°C climate target. Besides the harvest from natural forests, newly established timber plantations are required for supplying construction wood. While this does not interfere with food production, a loss of biodiversity may occur if not carefully managed, according to the scientists. The study is the first to analyze the impacts of a large-scale transition to timber cities on land use, land-use change emissions, and long-term carbon storage in harvested wood products.

"More than half the world's population currently lives in cities, and by 2100 this number will increase significantly. This means more homes will be built with steel and concrete, most of which have a serious carbon footprint," says Abhijeet Mishra, scientist from the Potsdam Institute for Climate Impact Research (PIK) and lead author of the study to be published in *Nature Communications*. "But we have an alternative: We can house the new urban population in mid-rise buildings—that is 4 to 12 stories—made out of wood."

Wood is known as a renewable resource that carries the lowest carbon footprint of any comparable building material as the trees take up CO_2 from the atmosphere to grow. Mishra explains: "Production of engineered wood releases much less CO_2 than production of steel and cement. Engineered wood also stores carbon, making timber cities a unique long-term carbon sink—by 2100, this could save more than 100Gt of additional CO_2 emissions, equivalent to 10% of the remaining carbon budget for the 2°C target."

More tree plantations, no reduction in land for food production—this is how it works

In the paper, with the help of the open-source global land use allocation model MAgPIE, the scientists looked at four different land-use

scenarios: One with conventional building materials like cement and steel, three with additional timber demand on top of the regular timber demand. They also analyzed how the additional high demand for wooden construction materials could be satisfied, where it could come from and what the consequences could be in direct and indirect carbon emissions from land-use.

"Our simulation shows that sufficient wood for new mid-rise urban buildings can be produced without major repercussion on food production," explains PIK scientist Florian Humpenöder, co-author of the study. "Wood is sourced from timber plantations as well as natural forests. Most of the additional timber plantations needed—we are talking about roughly 140 million hectares—are established on harvested forest areas and thus not at the cost of agricultural land," as Humpenöder underlines. "We need farm land to grow food for the people—using it to grow trees could potentially cause competition for the limited land resources."

Increasing forest harvest levels while protecting the most valuable forests

The scientists also looked at biodiversity impacts that occur when natural ecosystems are replaced with timber plantations. Alexander Popp, head of the land use management group at PIK scientist and co-author of the study, explains, "The question of how and from where to source the wood for the construction of timber cities is crucial. In our computer simulations, we have set a clear limit to timber extraction and for adding new tree plantations: Nothing can be cut off in pristine forests and biodiversity conservation areas."

In fact, Popp says, "The explicit safeguarding of these protected areas is key, but still, the establishment of timber plantations at the cost of other

non-protected natural areas could thereby further increase a future loss of biodiversity." Other studies indicate that measures such as a transition to healthy diets with less meat consumption could help to free-up land for wood and food production while conserving biodiversity.

Mishra says, "Our study underlines that urban homes made out of wood could play a vital role in climate change mitigation due to their long-term carbon storage potential. Strong governance and careful planning are required to limit negative impacts on biodiversity and to ensure a sustainable transition to timber cities."

John Schellnhuber, director emeritus of the Potsdam Institute for Climate Impact Research, says, "The key challenge for global sustainability is the deep co-transformation of land use and construction. If carefully integrated, these two sectors can remove and store crucial amounts of carbon from the atmosphere without jeopardizing food security or biodiversity. This could become the climate solution we have been desperately looking for."

Galina Churkina of TU Berlin says, "Increasing carbon storage in cities in parallel to land ecosystems is very important for this transition to succeed as a climate change mitigation strategy. Forests have to regrow after harvest and accumulate at least as much carbon as they stored before. The lifespan of timber buildings has to be at least as long as the time needed to repay 'the carbon debt' in harvested forests on a sustainable basis."

More information: Abhijeet Mishra, Land use change and carbon emissions of a transformation to timber cities, *Nature Communications* (2022). DOI: 10.1038/s41467-022-32244-w.
www.nature.com/articles/s41467-022-32244-w