Buildings made of wood instead of cement and steel could be important global carbon sinks

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A material revolution replacing cement and steel in urban construction with wood can have double benefits for climate stabilization, a new

study shows. First, it can avoid greenhouse gas emissions from cement and steel production. Second, it can turn buildings into carbon sinks as they store the CO_2 taken up from the air by trees that are harvested and used as engineered timber. However, while the required amount of timber harvest is available in theory, such an upscaling would clearly need careful, sustainable forest management and governance, the international team of authors stresses.

"Urbanization and population growth will create a vast demand for the construction of new housing and commercial buildings—hence the production of cement and steel will remain a major source of greenhouse gas emissions unless appropriately addressed," says the study's lead-author Galina Churkina who is affiliated to both the Yale School of Forestry and Environmental Studies in the U.S. and the Potsdam Institute for Climate Impact Research in Germany (PIK). "Yet, this risk for the global climate system could be transformed into a powerful means to mitigate climate change by substantially increasing the use of engineered timber for construction worldwide. Our analysis reveals, that this potential can be realized under two conditions. First, the harvested forests are sustainably managed. Second, wood from demolished timber buildings is preserved on land in various forms."

Four scenarios of timber use to help climate stabilization

Four scenarios have been computed by the scientists for the next thirty years. Assuming business as usual, just 0.5 percent of new buildings are constructed with timber by 2050. This could be driven up to 10 percent or 50 percent, if mass timber manufacturing increases accordingly. If countries with current low industrialization level also make the transition, even 90 percent timber is conceivable, the scientists say. This could result in storing between 10 million tons of carbon per year in the

lowest scenario and close to 700 million tons in the highest scenario. In addition, constructing timber buildings reduces cumulative emissions of greenhouse gases from steel and cement manufacturing at least by half. This might seem not so much compared to the current amount of roughly 11000 million tons of carbon emissions per year, yet the shift to timber would make quite a difference for achieving the climate stabilization targets of the Paris agreement.

Assuming a continued building with concrete and steel and assuming an increase in the floor area per person, following past trends, the cumulative emissions from mineral-based construction materials might reach up to one fifth of the CO_2 emissions budget up to 2050—a budget that should not be exceeded if we want to keep warming at well below 2°C as promised by governments in the Paris agreement. Importantly, to reach net zero emissions by mid-century, societies need some kind of CO_2 sinks to balance remaining hard-to-avoid emissions namely from agriculture.

Buildings could be such a sink—if made from timber. A five-story residential building structured in laminated timber can store up to 180 kilos of carbon per square meter, three times more than in the above ground biomass of natural forests with high carbon density. Still, even in the 90 percent timber scenario the carbon accumulated in timber cities over thirty years would sum up to less than one tenth of the overall amount of carbon stored aboveground in forests worldwide.

"Protecting forests from unsustainable logging is key"

"Protecting forests from unsustainable logging and a wide range of other threats is thus key if timber use was to be substantially increased," co-author Christopher Reyer from PIK emphasizes. "Our vision for sustainable forest management and governance could indeed improve the situation for forests worldwide as they are valued more."

The scientists summarize multiple lines of evidence from official harvest statistics to complex simulation modeling to find that, theoretically, unexploited wood harvest potentials would cover the demand of the 10 percent timber scenario. It might even cover the demand of the 50 and 90 percent timber scenario if the floor area per person in buildings worldwide would not increase but stay at the current average. "There's quite some uncertainty involved, yet it seems very worth exploring," says Reyer. "Additionally, plantations would be needed to cover the demand, including the cultivation of fast-growing Bamboo by small-scale landowners in tropical and subtropical regions."

Reducing the use of roundwood for fuel—currently roughly half of the roundwood harvest is burnt, also adding to emissions—would make more of it available for building with engineered timber. Moreover, re-using wood from demolished buildings can add to the supply.

The technology of trees—"to build ourselves a safe home on Earth"

Timber as a building material comes with a number of interesting features detailed out in the analysis. For instance, large structural timbers are comparatively fire resistant—their inner core gets protected by a charring layer if burnt, so it is hard for a fire to really destroy them. This is in contrast to popular assumptions fostered by fires in light-frame buildings. Many national building codes already recognize these properties.

"Trees offer us a technology of unparalleled perfection," Hans Joachim Schellnhuber says, co-author of the study and Director Emeritus of PIK. "They take CO_2 out of our atmosphere and smoothly transform it into oxygen for us to breathe and carbon in their trunks for us to use. There's no safer way of storing carbon I can think of. Societies have made good

use of wood for buildings for many centuries, yet now the challenge of climate stabilization calls for a very serious upscaling. If we engineer the wood into modern building materials and smartly manage harvest and construction, we humans can build ourselves a safe home on Earth."

More information: Buildings as a global carbon sink, *Nature Sustainability*, DOI: 10.1038/s41893-019-0462-4 , nature.com/articles/s41893-019-0462-4

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