PSC-JRC Collaborative Doctoral Program

The PSC-JRC Collaborative Doctoral Program is a hosted by ETH Zurich, University of Zurich and the Joint Research Center (JRC). The JRC's mission is to support EU policy and decision-making. The program started in 2019 and awarded four PhD student fellowships in the topics "Bio-economy and forests" and "Soil and land use change". The PhD students are enrolled in the Science and Policy PhD program coordinated by the PSC.

www.plantsciences.uzh.ch/en/research/fellowships/jrc.html

Bio-economy and forests

Releasing global forests from human management: How much more carbon could be stored?

According to the Intergovernmental Panel for Climate Change (IPCC), we need to reach carbon neutrality by 2050 to limit global warming to a safe, manageable level. The pathways that have been designed to reach carbon neutrality not only depend on strong CO_2 emission cuts but also rely on carbon sinks to remove some CO_2 from the atmosphere. One of the most important global carbon sinks comes from forests. In the past decades, almost one-third of all emissions were absorbed by vegetation. However, the global impact of management (for example, harvesting) on the carbon budget of forests remains poorly quantified.

During his fellowship, PhD student Caspar Roebroek brought together competences on climate modelling and satellite data analysis skills in line with the European Union's trajectory to becoming net carbon neutral in the coming decades.

One proposed forest-based strategy for climate change mitigation is to reduce forest management – such as logging – in order to increase the amount of carbon stored in forests. As part of his PhD, Caspar worked on defining a theoretical ceiling on carbon storage in trees to estimate how much more carbon they could hold in the complete absence of management. Although hypothetical, this scenario gives us insight into how much such strategies could, at best, contribute to climate change mitigation. Comparing this hypothetical potential carbon storage to the current amount of carbon stored in forests gives us the additional carbon storage potential (CSP), presented in Figure 1 at a global and country scale. The results were published earlier this year in *Science* (Roebroek et al. 2023). In this paper, the authors describe that this strategy would store at most 45 petagrams of carbon, approximately equivalent to 4–5 years of all human CO_2 emissions combined (at the 2019 rate).

Another proposed forest-based climate change mitigation strategy is to increase the amount of land covered with forests, by reforesting previously forested areas or afforesting areas that have not (recently) been covered with trees. However, storing enough carbon to mitigate climate change in a meaningful way requires massive amounts of land. The research team found that to compensate for even a single year of global CO_2 emissions, about 1.6 million km^2 of land is needed. To put this into perspective, this is an area larger than Germany, France and Spain combined. This strategy is complicated by the strong competition for land presented by agriculture and urban expansion, which is especially prevalent given the projected population increase in the coming decades.

Together, storing carbon in existing forests by forgoing management practices and planting new forests has the potential of sequestering CO_2 from the

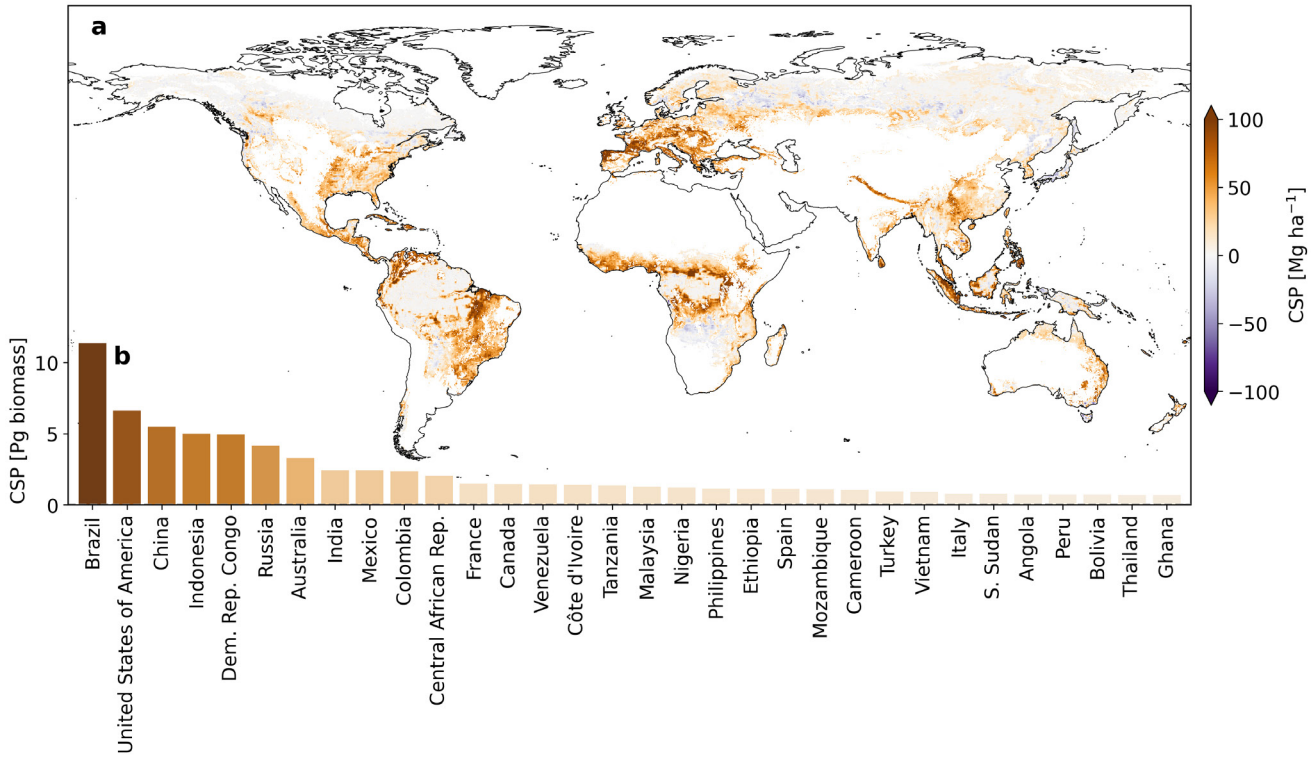

Figure 1: Carbon storage potential. (a) Additional carbon storage potential (CSP) in the hypothetical scenario in which all forests would return to their natural equilibrium if all direct human management was removed from them. The CSP is calculated from the difference between biomass carrying capacity and the expected biomass (the biomass that would occur under local conditions with the given natural disturbance regime and average intensity of human intervention). (b) National statistics of additional CSP for countries where absolute values exceed 0.7 Pg biomass (Roebroek et al. 2023).

atmosphere and compensating for carbon emissions. The scale of these processes is, however, insufficient to really compensate for the current rates of emissions. This carbon sink should instead be used to reach carbon neutrality by compensating for only the emissions of sectors which we currently cannot decarbonize (quickly), such as construction and agriculture, when all other emissions have been drastically reduced. The data and insights produced in this PhD project could be used as a tool to start this conversation. Forests are no silver bullet that we can use to compensate for our (in)actions, but they are a resource that might guide us collectively through a transition phase.

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Reference

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