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Linking plant functional traits and forest carbon stocks in the Congo Basin

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Accurate estimates of the amount of carbon stored in tropical forests represent crucial baseline data for recent climate change mitigation policies. Such data are needed to quantify possible emissions due to deforestation and forest degradation, and to evaluate the potential of these forests to act as carbon sinks. Currently, only rough estimates of the carbon stocks for Central African tropical forests are available due to a lack of field data, and little is known about the response of these stocks to climate change. We present the first ground-based carbon stock data for the central Congo Basin in Yangambi, D. R. Congo, based on data of 20 inventory plots of 1 ha covering different forest types. We found an average aboveground carbon stock of 163 $\pm$ 19 Mg C ha-1 for intact old-growth forest, which is significantly lower than the stocks recorded in the outer regions of the Congo Basin. Commonly studied drivers for variations of carbon stocks include climatic and edaphic factors, but detailed trait-based studies are lacking. We identified a significant difference in height-diameter relations across the Congo Basin as a driver for spatial differences in carbon stocks. The study of a more detailed interaction of the environment and the available tree species pool as drivers for differences in carbon storage could have large implications. The effect of the species pool on carbon storage can be large since species differ in their ability to sequester carbon, and the collective functional characteristics of plant communities could be a major driver of carbon accumulation.

The use of a trait-based approach shows high potential for identifying and quantifying carbon stocks as an ecosystem service. We test for associations between functional trait values and carbon storage across multiple regrowth and old-growth forests types in the Yangambi study area, with soil properties and climate similar for all plots. A selection of traits associated with carbon dynamics is made, including leaf traits (specific leaf area, leaf dry matter content, leaf carbon concentration, leaf nitrogen and phosphorus concentration, 13C, 15N, 18O), stem traits (wood density, vessel diameter), and vegetative traits (tree height, light tolerance), studying 990 individuals covering 111 species.

To develop a more coherent understanding of ecosystem functioning, the related carbon sequestration, and the contribution of climate and soil factors in tropical forests in the Congo Basin, we present a preliminary spatial study of plant functional traits and diversity by comparing several sites across the Congo Basin.