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Assessing the resources and mitigation potential of European forests

Hubert Hasenauer (1), Mathias Neumann (1), Adam Moreno (2), and Steve Running (3)

(1) University of Natural Resources and Life Science, Institute of Silviculture, Department of Forest- and Soil Sciences, Wien, Austria (mathias.neumann@boku.ac.at), (2) NASA Ames Research Center, Mail Stop 204-14, Moffett Field, CA 94035-0001, USA (adam.l.moreno@nasa.gov), (3) Numerical Terradynamic Simulation Group, College of Forestry & Conservation, The University of Montana, Missoula, MT 59812, USA (swr@ntsg.umt.edu)

Today 40 % of the European land area is covered with forests managed for the provision of ecosystem services including timber production. Forests store large amounts of carbon and are the main resource for the growing demand of a bio-based economy. They are also a major source for biodiversity. Thus a consistent pan-European gridded data set on the state of forest resources is essential for researchers, policy makers and conservationists to study and understand the European forests for the global carbon cycle independent of political boundaries. The purpose of this study is to use existing European data to develop a consistent pan-European data set for Net Primary Production (NPP), live tree carbon per hectare, volume per hectare, mean tree height and mean tree age by integrating remotely sensed satellite data and harmonized NFI data from 13 different European countries. We provide new NPP estimates using the MOD17 algorithm by collating a newly down-scaled daily climate dataset across Europe. By consolidating these two independent productivity data sources (top down satellite versus bottom up terrestrial forest NFI data) for assessing forest resources in Europe, we are able to detect and quantify forest management impacts. We produce a pan-European map for each of the five key variables on a 0.133° grid representing the time period 2000-2010. The results show distinct differences in the carbon storage of European forests due to biophysical limits and regional historic drivers in forest management, which directly affect the carbon mitigation option of European forests. We use this data to assess the state of forest resources across Europe showing that mountainous regions have the highest carbon and volume per hectare values, central Europe has the tallest mean tree heights and Austria and Northern Scandinavia have the oldest mean tree ages. Cross-validation of the data indicates that the error varies by forest characteristic but shows negligible biases for all. We also use this data to examine climate limitations on potential forest structure, relevant for assessing potential timber assortments or suitability as wildlife habitat. The results suggest: (i) Boreal forests are limited by minimum temperature, the Mediterranean forests by maximum temperature and temperate forests by both temperature and precipitation. As a result of changing climate during the last 50 years, the potential average diameter at breast height, which can be achieved in Europe, has decreased by 5.0 %. A similar result is evident for the potential basal area per hectare with a decrease of 6.5 %. (ii) European forests exhibit an annual average carbon uptake of 577 gC/m^2/year, which can be considered as the carbon sequestration potential and/or available resource for the increasing demand of a growing bio-economy.