



Effects of forest management on carbon and energy exchange of beech forests

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Atmospheric carbon and energy fluxes of a managed beech forest are compared with those of a nearby unmanaged, old-growth beech forest in central Germany. Both forests are located at similar altitude and they face similar meteorological conditions. They are also similar with respect to canopy height (37 m) and mean tree age (120 years). The managed forest is a monospecific, even-aged stand with species-rich ground vegetation and a leaf area index of about 4, whereas the old stand is clearly beech-dominated but interspersed with ash and sycamore trees. It has a multi-layer canopy made up of trees of various ages and its leaf area index is about 5. The comparison is based on 23 site-years of eddy covariance measurements of carbon and energy fluxes and on regular biomass measurements in terms of dendrometry and litter collection.

On average the two forests did not differ significantly in annual net carbon uptake derived from eddy covariance data (508 and 483 g C m⁻²a⁻¹ for the managed and the unmanaged forest, respectively), however the managed forest showed a much larger interannual variability in gross primary production than the unmanaged forest did. This trend agreed well with independent dendrometric measurements of net ecosystem production from both forests. In contrast, ecosystem respiration did neither vary significantly between the two forests nor between different years. The total annual evapotranspiration was higher at the unmanaged forest site (549 mm a⁻¹ compared to 504 mm a⁻¹ at the managed site), which was probably due to a higher interception loss from the denser canopy in the unmanaged forest.

We discuss whether the conclusion can be drawn from this case study that common forest management activities improve the water use efficiency of European beech forests but make them more vulnerable, in terms of carbon uptake, against extreme meteorological conditions such as, for example, summer heat waves or late frosts in springtime. Regardless of this discussion the results demonstrate that the stop of management activities does not immediately alter the carbon balance of a beech forest. Instead an unmanaged forest can remain a substantial carbon sink for many decades.