Geophysical Research Abstracts
Vol. 15, EGU2013-5651, 2013
EGU General Assembly 2013

A fertile peatland forest constitutes no major greenhouse gas sink

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Organic soils drained for agriculture have been identified as potential large sources of greenhouse gases (GHG), such as CO_2, N_2O, and CH_4. As a mitigation strategy to limit the GHG effluxes of these soils afforestation has been suggested, because the C accumulation in tree biomass is assumed to balance soil effluxes of GHG, which would turn the ecosystem into an overall GHG sink. However, the magnitude of soil GHG effluxes and the carbon accumulation in tree growth has been shown to be highly dependent on a number of factors from which the soil nutrient and the drainage level are of major importance. Year-round measurements of all GHGs of nutrient-rich afforested organic soils are scarce, so that the overall GHG budget remains uncertain. The scarcity of studies can partly be explained by the uncertainties involved in methodology.

This study reports the ecosystem fluxes of CO_2, N_2O, and CH_4 of a spruce dominated forest on a drained organic soil with an agricultural history in Sweden. A direct (eddy covariance) as well as an indirect (analysing the different terms of the GHG budget) approach have been used to determine the net ecosystem CO_2 exchange (NEE), so that uncertainties in the respective method could be evaluated. The annual tree production in 2008 was 30.1 ($\pm$ 6.2) t CO_{2eq} $ha^{-1}yr^{-1}$. N_2O fluxes were determined by the closed chamber technique and amounted to 3.3 t CO_{2eq} $ha^{-1}yr^{-1}$. Independent of the approach applied, the C sequestration by trees counters large amounts of the soil CO_2 effluxes, however according to the direct approach by the eddy covariance technique, the site acts as a GHG sink of -4.1 t CO_{2eq} $ha^{-1}yr^{-1}$. This contrasts the NEE estimate gained through the indirect approach, which suggests that the site is a net GHG emitter of 3.3 t CO_{2eq} $ha^{-1}yr^{-1}$.

Due to major uncertainties involved in the indirect approach, it was concluded that the direct approach is the more reliable method, suggesting the site to be a GHG sink. However, as the site was in its optimum growth stage, i.e. the rate of carbon sequestration was at its' maximum and will decrease with forest age, it will likely turn into a GHG source again. In general, forests in their younger stage are usually GHG sources or neutral, so that the overall GHG sink potential of this afforested nutrient-rich organic soil is likely to be limited to a rather short time period. The long-term GHG sink potential of nutrient-rich afforested organic soils must thus be questioned and it is recommended that future GHG mitigation strategies take the site-specific properties into account.