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Soil Organic Carbon Dynamics in Two Chronosequences of Mineral Hydromorphic Soils

Marie Spohn and Luise Giani

Soil Science Group, Department of Biology and Environmental Sciences, Carl von Ossietzky University Oldenburg, 26111 Oldenburg, Germany

While soil organic carbon dynamics in organic hydromorphic soils have broadly been studied, little attention has been paid to mineral hydromorphic soils. However, it is assumed that carbon stocks in mineral hydromorphic soils react very sensitively to land use changes.
To get detailed insight into the development of soil organic carbon dynamics following land use conversion from pasture to cropland at the landscape level, two chronosequence studies were conducted: One on groundwater affected sandy soils (Haplic Gleysols and Gleyic Podzols) and on stagnant water affected soils (Stagnosols). The zero point of each chronosequence was represented by permanent pasture sites, while the following sites have been converted from pasture to cropland at different times in history. To gain further insight into the impacts of different types of land use on carbon sequestration, soils under primary and secondary forest were studied.
In both chronosequences the loss of soil organic carbon after conversion of land use from permanent pasture to cropland followed a monoexponential decay. In the chronosequence of the Stagnosols, the total organic carbon (TOC) stocks in the uppermost 20 cm decreased from initially 195.2 t ha-1 in the permanent pastures to 45.1 t ha-1 TOC in the 110-year cropland soils. In the second depth interval (20 - 40 cm), the TOC stocks decreased from 68.0 to 25.8 t ha-1 during the same time. The TOC stocks reached a new equilibrium 23 ($\pm$ 5) years after the land use conversion. In the groundwater affected soils the TOC stocks decreased from 71.9 t ha-1 to 28.7 t ha-1 in the uppermost 20 cm of the soils. The major reason for the different TOC concentrations in the groundwater affected soils and in the Stagnosols is most probably the strong drainage of the groundwater affected soils, which already lead to a strong loss of TOC prior to the land use conversion. Additionally, it was found that the TOC stocks in the groundwater effected permanent forest soils were significantly higher than in the soils, which have be afforested 100 - 150 years ago.
From the two chronosequence studies we conclude that conversion from pasture to cropland of mineral hydromorphic soils is associated with large losses of TOC. Secondly, the studies show that an afforested soil can need more than 100 years to establish TOC stocks, which are comparable to those of primary forest soils. Finally, we conclude that land use history is central for understanding carbon dynamics at the regional or landscape scale.