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C loss of managed peatlands along a land use gradient – a comparison of three different methods

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Carbon (C) loss from managed organic soils is an important flux in the global carbon cycle. Different approaches exist to estimate C emissions and thus the greenhouse gas balance of soils. Here we compare two soil profile-based methods with greenhouse gas flux measurements by closed chambers to assess the net C loss from managed peatlands. We applied the different methods to the well-studied peatland complex Ahlen-Falkenberger Moor in northern Germany, which represents a land use gradient from near-natural wetland (NW) to extensively used grassland (GE) (rewetted in 2003/2004) to intensively used grassland (GI). Drainage commenced at the beginning of the 20th century, and land use was intensified in the middle of the 20th century. In November 2012, three peat cores down to approximately 100 cm were taken at each site and various biogeochemical soil parameters were analysed. The so-called combined method estimates the physical primary subsidence due to the loss of pore water and peat shrinkage, and the secondary subsidence due to the oxidative loss of organic matter. As a second method C loss was calculated using peat accumulation rates derived from 14-C age-dated samples and their C-stock in this depth. These two profile-based methods give the C loss since the onset of drainage. Compared to this, the greenhouse gas (GHG) measurements (2007-2009) represent the current C loss from the soil under given climate and management conditions.

All three sites have lost C since the onset of drainage in the order NW<GE<GI. Based on current chamber-derived GHG measurements site NW accumulates C, site GE shows a neutral C balance and GI is a C source for the years 2007 to 2009. In total the NW site had lost 13 t C ha^{-1} according to the 14-C method and 115 t C ha^{-1} according to the combined method. Chamber measurements indicate NW to be nowadays a C sink of about 1 t C ha^{-1} a^{-1}. Site GE had lost C (382 t C ha^{-1} by the 14-C method and 188 t C ha^{-1} by the combined method) due to drainage and management activities and is, based on the chamber measurements C neutral since the rewetting. Site GI had lost the most (528 t C ha^{-1} according to the 14-C method and 429 t C ha^{-1} according to the combined method) and reveals currently high annual C emissions (11 t C ha^{-1} a^{-1} for 2007-2009). This flux is higher than the average annual mean calculated from the profile methods (average since drainage intensification 7-9 t C ha^{-1} a^{-1}). A comparison of these methods demonstrates that the historical C loss can be assessed by the two profile-based methods, an information which is not delivered by the flux measurements. Reasons for different estimates of C loss still need to be explored. Present changes in the C balance were captured by the flux measurements which are not displayed in the profile-based methods. Taken together, profile based and flux measurements indicate that the C balance of these peatlands is changing over time.