Geophysical Research Abstracts
Vol. 21, EGU2019-9246-1, 2019
EGU General Assembly 2019

Carbon loss and subsidence in relation to organic soil properties in Central and Northern Europe - evaluating a numerical approach for reference layer identification with bootstrap resampling and stable carbon isotopes

Arndt Piayda, Liv Sokolowsky, and Bärbel Tiemeyer
Thünen Institute of Climate-Smart Agriculture, Braunschweig, Germany (arndt.piayda@thuenen.de)

Intact peatlands are a cooling factor for climate since they are the most efficient carbon sinks of all terrestrial ecosystems. However, once these organic soils have been drained, fast mineralization takes place and they are strong greenhouse gas emitters and suffer from land surface subsidence. Around half of all natural peatlands in Europe have already been lost, mainly due to agriculture and forestry. A commonly used method to estimate carbon loss and subsidence from organic soils is the profile-based ash residue method, in particular when there is no adjacent, undisturbed reference site. Increased density and ash content in the disturbed top soil are related to the undisturbed subsoil. Although a high reliability of estimated carbon loss and subsidence can be expected when all underlying assumptions are met, uncertainty arises from the subjective identification of the undisturbed reference layer.

In this study, we used the ash residue method to determine subsidence and carbon losses from peat cores (three replicates per site) taken at 17 drained and cultivated fen peatland sites in Denmark, Estonia, Finland, Germany and the Netherlands. All cores were cut into 3 cm segments and analyzed for bulk density and loss on ignition (LOI). The ash residue method requires the user to identify the transition depth between the disturbed top layer(s) and the undisturbed reference layer as well as the transition depth to the mineral subsoil. Traditionally, this is done by visual inspection of the data and subjective decision. In order to avoid user bias and improve reproducibility and comparability of the results, we present a standardized numerical approach based on two slope thresholds of the LOI profile and assess its uncertainty based on parameter bootstrap. We compare results with the subjective "best guess" approach, literature values for reference layer properties and δ^{13}C profiles.

Estimated carbon losses of all 17 sites ranged from nearly zero to 909 ($\pm$101) t ha^{-1} and corresponding total subsidence between zero and 1.44 ($\pm$0.13) m. Strongest correlations of carbon loss and subsidence values were found with bulk density and porosity as well as organic carbon density and carbon to nitrogen ratio, while site and management attributes as well as other soil physical and chemical properties were only loosely correlated. It was feasible to parameterize the two LOI slope thresholds of the numerical approach with a single parameter set for all 17 sites despite the large variability in peat depth, drainage history and land use type, enabling a standardized identification of the reference layer and thus unbiased data processing. On average, the uncertainty of the parameters determining the transition depths and thus, the reference layer position and extend, contributed less to the total uncertainty of estimated carbon loss and subsidence results than the spatial variation among replicate cores. The identified reference layers showed homogeneous δ^{13}C values, indicating a negligible impact of aerobic decomposition. First results comparing properties of the reference layer with literature values of LOI yielded a good match. However, further research needs to evaluate the transferability of the numerical approach to unseen data.