Project brief

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Soil hydraulic properties and release of CO_2 from peat soils

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- **Evaluation and adjustment of soil physical methods for the application to peat soils**

Background and aims

Worldwide, peatlands are drained for economic use, and as a result, they have become a source of greenhouse gases. Besides water levels, soil hydrological, physical, and chemical properties of peat are crucial controlling parameters. However, due to the substantial differences between peat and mineral soils, established measurement devices as well as methods of sampling and analysis are not always suitable. In the project presented here, knowledge gaps in the measurement and evaluation of key parameters for greenhouse gas emissions from peatlands were evaluated and further developed.

Methods

In individual laboratory and field studies, studies were conducted with various peat soils to (1) improve soil moisture measurements, (2) determine the ideal drying temperature for sample preparation, (3) derive hydraulic properties from evaporation experiments, (4) determine the water content at the permanent wilting point, and (5) identify suitable devices for accurate volume-based sampling for the determination of bulk density and thus stocks of soil organic carbon.

Results

1. The higher water contents in peat soils (up to 98%) compared to mineral soils and the associated high relative dielectric permittivity can be measured with some, but not all, commercial soil moisture probes (Dettmann and Bechtold, 2018).
2. Contrary to widespread belief, peat soils can be dried at 105 °C before determining carbon and nitrogen contents. At drying temperatures below 80 °C, carbon and nitrogen contents are underestimated due to the residual water content (Dettmann et al., 2021).
3. The selection of an appropriate evaluation method for determining the hydraulic properties of peat soils depends on the intended application and the moisture conditions (Dettmann et al., 2019).
4. Measurement devices such as pressure plate apparatus and pressure membrane apparatus can be used to determine the water content at the permanent wilting point (Bechtold et al., 2018).
5. For volume-based sampling of peat soils, gouge auger and Russian corer show no significant differences to the reference method (steel cylinder). For the Russian corer, however, this only applies under saturated conditions (Dettmann et al., 2022). For highly degraded and unsaturated topsoils, however, steel cylinders are the only appropriate choice.

Conclusions

Many established methods can be applied to peat soils, but they must be evaluated and, if necessary, adjusted beforehand.

Figure: Laboratory for Soil Physics and Peat (Source: Ullrich Dettmann).

Further Information

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Dettmann et al. (2022), How to take volume-based peat samples down to mineral soil? Geoderma 427:116132 DOI:10.1016/j.geoderma.2022.116132

Dettmann U (2021), Analysis of peat soil organic carbon, total nitrogen, soil water content and basal respiration: Is there a 'best' drying temperature? Geoderma 403:115231 DOI:10.1016/j.geoderma.2021.115231

Dettmann et al. (2019), Evaporation experiments for the determination of hydraulic properties of peat and other organic soils: An evaluation of methods based on a large dataset. J Hydrol 575:933-944 DOI:10.1016/j.jhydrol.2019.05.088

Bechtold et al. (2018), Comparing methods for measuring water retention of peat near permanent wilting point. Soil Sci Soc Am J 82(3):601-605 DOI:10.2136/sssaj2017.10.0372

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