Century-Scale Shifts in Peat Hydro-physical Properties as Induced by Drainage

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Objectives

The shift in hydro-physical parameters after peatland drainage has not been explicitly addressed in previous studies despite the availability of hydraulic data from numerous drained peatlands. In this study, a dataset of peat subsidence and BD change rates as a function of time after drainage was assembled from 28 published papers. The objectives of this study are to:

(1) derive functions between time since drainage and land subsidence and BD on a century-scale.

(2) determine the hydro-physical properties of peat on a century-scale based on the BD-drainage period functions.

Peatland drainage and subsidence

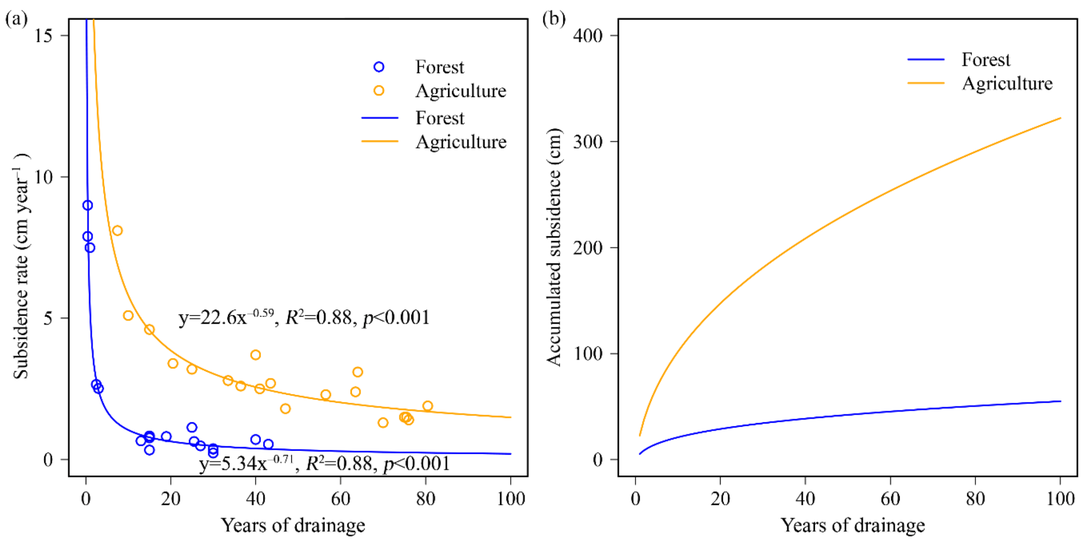

Figure 1. Scatter plots of subsidence rate versus time since drainage for agricultural (derived from Pronger et al., 2014, with permission) and for forest peatlands (a) and accumulated subsidence during 100 years' drainage.

Peatland drainage and bulk density

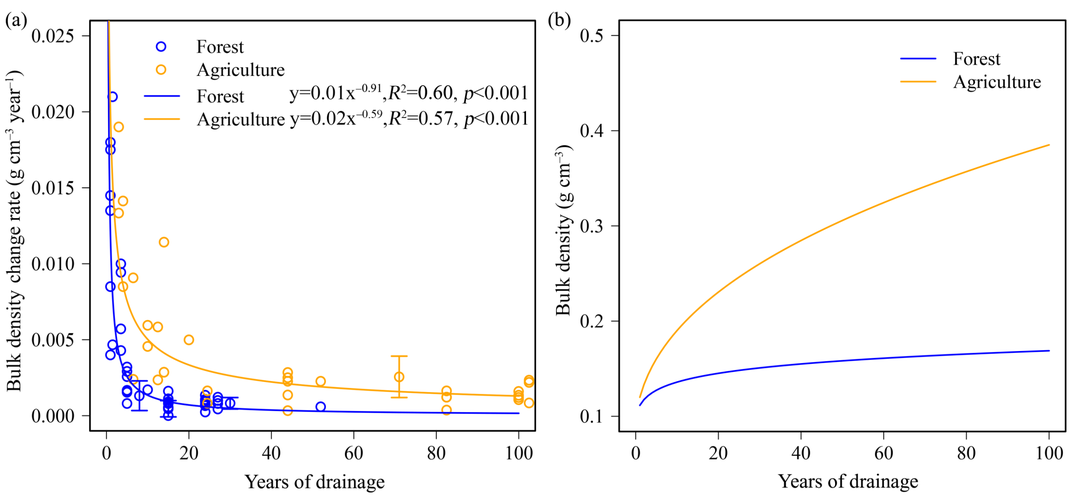

Figure 2. Scatter plots of peat bulk density change rate versus time since drainage (a) and soil bulk density during 100 years' drainage for forest and agriculture peatlands. The bars denote the standard deviations (n>6).

Reference:

Liu, H., & Lennartz, B. (2019). Hydraulic properties of peat soils along a bulk density gradient – A meta study. Hydrological Processes, 33, 101–114. doi:10.1002/hyp.13314

Pronger, J., Schipper, L. A., Hill, R. B., Campbell, D. I., & McLeod, M. (2014). Subsidence rates of drained agricultural peatlands in New Zealand and the relationship with time since drainage. Journal of Environmental Quality, 43(4), 1442. http://dx.doi.org/10.2134/jeq2013.12.0505.

Supplemental information

This is a meta study. The dataset was basically collected from the published literatures. For more detailed information, please contact haojie.liu@uni-rostock.de

Pore structure and hydro-physical properties

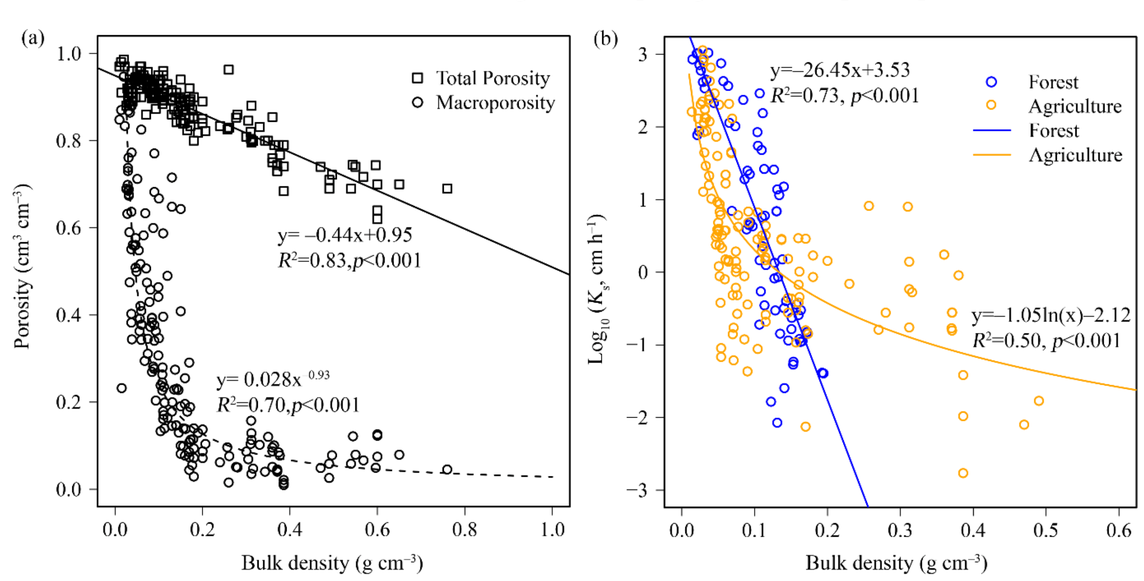

Figure 3. Relation between peat bulk density and porosity (total porosity as well as macroporosity) (a), and relation between the peat bulk density and saturated hydraulic conductivity (K_s) (b). Data source: Liu and Lennartz, 2019.

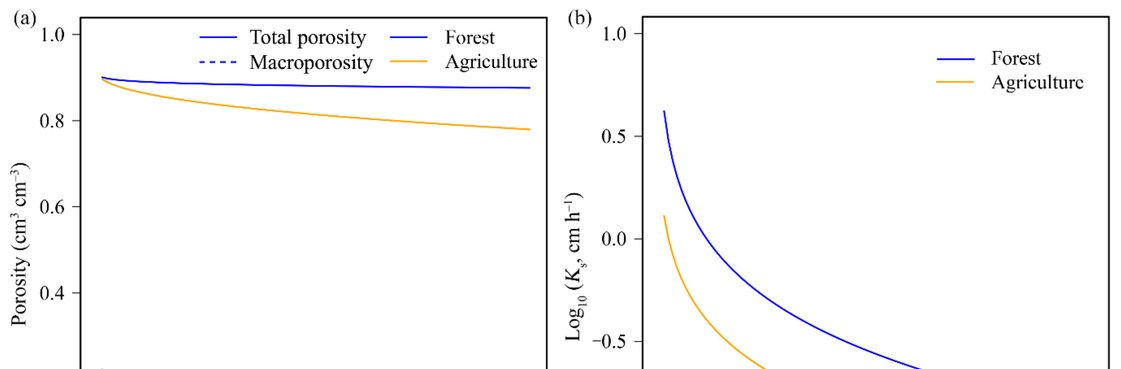

Figure 4. Changes in porosity (total porosity and macroporosity) (a) and saturated hydraulic conductivity (K_s, b) during 100 years of drainage for forest and agriculture peatlands. The values are calculated based on the functions shown in Figures 2 and 3.

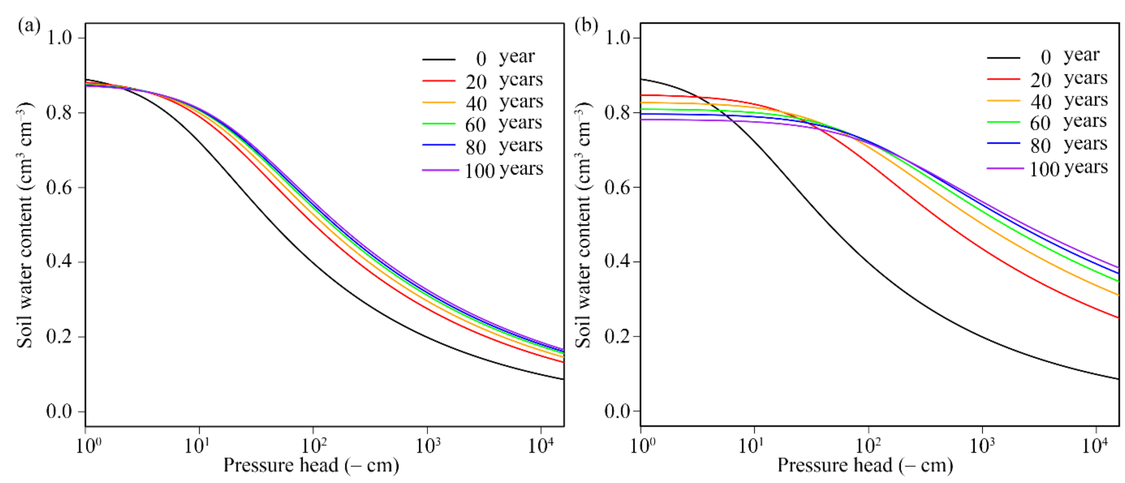

Figure 5. Changes in soil water retention curves after 0, 20, 40, 60, 80, and 100 years of drainage for forested (a) and agriculture peatlands (b). The functions between BD and van Genuchten parameters can be found in Liu and Lennartz, 2019.

Concluding Remarks

- Hydro-physical properties of peat can be estimated based on its drainage duration and land use.
- In forested and agricultural peatland, the most severe shift in peat properties occurs within the first 20 years following drainage.
- The derived hydro-physical parameter values can be used for long-term hydrological modelling, especially if measured hydraulic parameters of peat are not available.

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