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Reference values for soil structural degradation evaluation: an approach using shrinkage analysis

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Introduction
Diagnosis of soil compaction and other soil structural degradation require reference threshold values defining non-degraded soil structure versus degraded soil structure. Large-scale application, e.g. for soil protection regulation, require accurate, cost-efficient and robust methods providing meaningful information with respect to soil quality. The shrinkage curve analysis (ShC)(Braudeau et al., 2004) does not only provide relevant parameters for soil functions such as water and air content of structural porosity but also holds promises to fulfil these requirements.
Our objective was to test the potential of ShC analysis to define reference values for soil structural degradation at Swiss scale.

Material and Methods
Agricultural soils of the most common soil order on the Swiss plateau, namely cambi-luvisol, were sampled. Undisturbed samples were collected from topsoil at 200 locations from spring 2012 to fall 2014 on a large area (240 km) across Switzerland. Three types of soil managements were represented, namely permanent pasture (PP), conventional tillage and no-till. Only soils showing no evidence of structural degradation, as assessed visually and according to a VESS score smaller than 3 (Ball et al., 2007), were sampled. Compaction, erosion, waterlogging and poor degradation of organic matter were criteria to discard sampling locations.
The undisturbed soil samples were analysed for SOC, texture, CEC and ShC, from which a set of parameters defining the soil porosities and hydrostructural stability was obtained.

Results and Discussion
The texture properties were similar between the different soil management, with clay content ranging from 10 to 35%. SOC content ranged from 0.5 to 4.5% and was significantly larger in average for PP, though the ranges were largely overlapping amongst the 3 soil managements.
ShC parameters were found to be highly determined by SOC, with the R2 of the regressions usually over 70%, regardless of soil management, large spatial coverage and time of sampling. Considering additional soil properties improved only poorly the prediction of the ShC properties.
These high predictions of physical parameters by SOC are partly due to the standardization with respect to matric potential or shrinkage transition points, which allows sharply decreasing the spatial and temporal variability. Consequently, a small number of samples (3-10) should accurately determine an average value of ShC parameters, with inexpensive and simple techniques.

Conclusion
For the considered soil order, at Swiss scale, a unique highly determined linear relation could be defined for most of the ShC parameters with respect to SOC. This relation defines the non-degraded reference state. Further comparison with degraded soil structures will show to which extent unambiguous detection of structural degradation can be performed on this basis in the perspective of soil quality regulation.

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