Geophysical Research Abstracts
Vol. 20, EGU2018-12934, 2018
EGU General Assembly 2018

Are compacted subsoil layers a problem in German croplands and grasslands? Results of the Agricultural Soil Inventory

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Densely-packed, compacted subsoil layers pose a barrier for root growth as well as for infiltrating water. This increases the intensity of floods and can be a threat to food production, especially in growing seasons with droughts. Compacted subsoil layers can be caused by agricultural management (e.g. plough pans). However, they can also be of natural origin and caused, for example, by clay illuviation. We used the German Agricultural Soil Inventory to study (i) the extent and distribution of compacted subsoil layers of agricultural land, and (ii) examined management, soil and geology related potential drivers for subsoil compaction in Germany.

The dataset consists of 3,057 sites covering German agricultural land in a grid of 8 km x 8 km. Each site contains data on soils down to 1 m depth (descriptions of soil profile and physico-chemical analysis in the laboratory), geology, land-use and management (farmer′s questionnaire). Compacted subsoil layers were described as a function of packing density (bulk density corrected by texture). Soil layers with packing densities > 1.75 g cm-3 were classified as compacted. Potential drivers for compacted soil layers were evaluated using the machine learning algorithm cforest.

About 25 % of German cropland was classified with compacted, root restricting subsoil layers in 30-50 cm depth. However, among grasslands, the estimated area of such layers was with only 12 % much lower. The trend of compacted subsoil layers being more common in croplands than in grasslands was independent of soil texture. Results from the machine learning algorithms confirm that land-use significantly explains the presence of compacted subsoil layers even after accounting for a wide range of physio-chemical soil characteristics and geology variables. This indicates that land-use indeed is a driver for the observed differences among packing densities and cropland land-use increases the risk of severe soil compaction. At about 40 % of all sites, continuous macro-pores took up > 2 Vol-% of the subsoil matrix in 30-50 cm depth. These macro-pores were mainly formed by anecic earthworms and may facilitate deeper rooting, aeration and water infiltration despite compacted bulk soil. Most biopores occurred in loamy and clayey soils in a restricted area south of a line between Aachen, Hannover and Magdeburg.

We will discuss our results in the light of a sustainable bio-economy that needs to take into account also subsoils and their resources. Without root access to subsoils due to compaction, agricultural management may be more vulnerable and less sustainable.