

Soil physical land degradation processes

Rainer Horn

CAU Kiel, Soil Science, Kiel, Germany (rhorn@soils.uni-kiel.de)

According to the European Soil Framework Directive (2006) soil compaction is besides water and wind erosion one of the main physical reasons and threats of soil degradation. It is estimated, that 32% of the subsoils in Europe are highly degraded and 18% moderately vulnerable to compaction. The problem is not limited to crop land or forest areas (especially because of non-site adjusted harvesting machines) but is also prevalent in rangelands and grassland, and even in so called natural non-disturbed systems. The main reasons for an intense increase in compacted agricultural or forested regions are the still increasing masses of the machines as well the increased frequency of wheeling under non favorable site conditions. Shear and vibration induced soil deformation enhances the deterioration of soil properties especially if the soil water content is very high and the internal soil strength very low. The same is true for animal trampling in combination with overgrazing of moist to wet pastures which subsequently causes a denser (i.e. reduced proportion of coarse pores with smaller continuity) but still structured soil horizons and will finally end in a compacted platy structure. In combination with high water content and shearing due to trampling therefore results in a complete muddy homogeneous soil with no structure at all. (Krümmelbein et al. 2013)

Site managements of arable, forestry or horticulture soils requires a sufficiently rigid pore system which guarantees water, gas and heat exchange, nutrient transport and adsorption as well as an optimal rootability in order to avoid subsoil compaction. Such pore system also guarantees a sufficient microbial activity and composition in order to also decompose the plant etc. debris. It is therefore essential that well structured horizons dominate in soils with at best subangular blocky structure or in the top A- horizons a crumbly structure due to biological activity. In contrast defines the formation of a platy structure down to deeper depth and/or in combination with the deterioration of a continuous pore system an intensely degraded soil. A dominating anisotropy of pore functions causes a lateral soil and water movement. Doerner and Horn (2006), documented the increasing effect of stress and shear affected horizontal anisotropy on the hydraulic and gas permeability which coincides with a retarded gas exchange and an increased proportion of e.g. CO₂ or even CH₄ in soil pores and hinders the normal population growth. If the internal soil strength is exceeded the microbial composition and activity is converted to anoxia and even results in the emission of CH₄ (Haas et al. 2016). Furthermore, the accessibility of nutrient adsorption places as well as connection between the pores within the compacted soils is decreased and results in a retarded ion mass flow and diffusion within the plates and /or in between the soil horizons. How to overcome these negative effects and how to deal with soils adequately according to their internal strength will be presented in the lecture – we need to improve the food production at an preserved land area for growing population.

Literature

Haas,C., Holthusen,D., Mordhorst,A., Lipiec,J., Horn, R. 2016. Elastic and plastic soil deformation and its influence on emission of greenhouse gases. *Int. Agrophys.*, 30, 173-184

Krümmelbein, J., R.Horn 2013: Cycle of Soil Structure. *Soil Degradation* 183-198, *Advances in Geoecology*, 42, Catena Verlag, ISBN: 978-3-923381-59-3