PhD project: Tobias Klöffel

Soil structure and water management in agricultural soils of the temperate and boreal zones in a changing climate

Soil structure is a key determining factor for the fertility and productivity of agricultural soils. By defining the soil pore space, soil structure is strongly linked to the water regulation function of soils through their water holding capacity and hydraulic conductivity and, with this, exerts an important influence on the plant-available water and drainage capacity. The pore space of agricultural soils is not static but changes on both short (i.e. within seasons) and long (i.e. up to centuries) timescales in response to various anthropogenic and natural factors acting in tandem. In this respect, climate represents a major variable by controlling soil temperature and moisture regimes, which influence the rate and magnitude of physical, chemical and biological soil processes. Besides this, climate determines the way soils are agriculturally managed. Climate can therefore have *direct* (e.g. through the impact of rainfall, freeze-thaw and wet-dry cycles) and *indirect* (e.g. root growth, soil biota activity, soil management, soil organic matter dynamics) effects on the soil pore space. Recent climate models project changes in temperature and precipitation patterns for the coming decades, which entails altered climatic boundary conditions for soils. This might result in potentially adverse effects and the need to adapt crop production in order to maintain (or increase) agricultural productivity.

The goal of this PhD project is to investigate potential effects of climate change on the soil pore space and their implications for the hydraulic properties of agricultural soils in Sweden. The main focus will be on climate-driven processes which exert a direct impact on the soil pore space. Specifically, changes in the intensity and number of freeze-thaw as well as wet-dry cycles will be investigated. Apart from this, the role of changing soil organic matter dynamics and vegetation cover will be explored.

To reach this goal, I will combine experimental work, statistical analyses and computer models: laboratory experiments will be conducted where different climatic conditions are simulated. Soil properties related to the soil pore space will be quantified using x-ray computed tomography, water retention properties and hydraulic conductivity measurements. Statistical analyses will help to relate specific climatic conditions to measurable soil hydraulic properties at larger spatial scales (Sweden, Scandinavia). Finally, I will use computer models to simulate potential implications of changed soil organic matter dynamics on the soil pore space.

The results of this project will contribute to an improved understanding of how climate change will affect the structural dynamics and states of Swedish agricultural soils. Focussing on the implications for soil hydraulic properties, this will inform adaptation measures with respect to water management to maintain (or even enhance) agricultural productivity.