Monitoring the temporal evolution of soil structure of three innovative production systems in the field

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SSS6.1: Soil structure dynamics and its relevance to soil functions: Feedbacks with soil biology and impacts of climatic conditions and soil management

Alternative agricultural practices emerge to provide more sustainable productions systems and to meet tomorrow's diets. These practices and varying climatic conditions will have impacts on soil structure and thus on soil hydraulic properties. However, most models do not consider the temporal variability of soil hydraulic properties, which can lead to poor decision making. Thus, quantifying the temporal evolution of hydraulic properties is essential to better understand the impact of emerging agricultural practices on soil structure (Chandrasekhar et al., 2018).

In most studies, temporal variation of soil hydraulic properties is investigated using punctual measurements in the field or in the laboratory (Alskaf et al., 2021; Geris et al., 2021). Results are often inconsistent between studies due to the timing and type of measurement performed (Chandrasekhar et al., 2018; Strudley et al., 2008). In addition, most research focuses on the topsoil layers and does not consider the longer term effects on the deeper layers of the soil (Wahren et al., 2009).

In this research, temporal evolution of the hydraulic properties of three innovative production systems is continuously monitored up to 90 cm depth. The three systems are designed to disrupt current agronomic trials and aim to produce the ingredients of tomorrow’s diets. They are pesticide-free and have long-term rotations of 8 years with intercrops. These systems are implemented on 8 parcels of the University of Gembloux Agro-Bio Tech on a typical loamy soil in Belgium.

The innovative systems were instrumented with 24 Teros 12 water content and 24 Teros 21 water potential sensors from MeterGroup. Both types of sensor are robust and highly accurate. The Teros 12 probes also measure soil temperature and salinity. Potential probes can measure potential over a wide range of values from -9 to -2000 kPa. All probes are connected to MeterGroup's ZL6 data loggers which allow real-time data collection. The water content and potential probes are placed in parallel in the first three soil layers at 30, 60 and 90 cm depth in 8 plots. Intact soil cores are also taken every two months to determine bulk density and total soil porosity.

The simultaneous determination of both water content and water potential over time under natural conditions allows the temporal evolution of the hydrodynamic properties to be captured at the level of the first three horizons. This monitoring will make it possible to quantify the temporal evolution of the structure of a loamy soil under the effect of alternative agricultural practices and varying climate conditions. The first two years were contrasted in climatic conditions with a wet and a dry year. In addition, a diverse range of agricultural practices with different crops such as beet, camelina, corn, rapeseed and winter wheat were grown in both years. The results of these first two years of monitoring will be presented at the EGU 2023 General Assembly and compared to theoretical properties that would be obtained using classical PTF.

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