MARTIN-LUTHER-UNIVERSITÄT
HALLE-WITTENBERG

UFZ HELMHOLTZ Zentrum für Umweltforschung

Soil Science Colloquium - Halle

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09. January 2025 - 4pm
UFZ lecture room E01, Theodor-Lieser-Straße 4, Halle
!! exceptional location !!

Soil structural indicators as predictors of biological activity under various soil management practices

Abstract:
Soil structure is a key feature in controlling the turnover of organic matter in soils. The spatial arrangement of solids and pores in agricultural topsoil can be actively influenced by management practices, such as tillage and cropping systems, which in turn can affect the resident microbial communities and their activities. However, carbon mineralisation and microbial activity are usually measured in sieved samples, which provides information on gross potentials under optimal conditions, but excludes spatial heterogeneities and may reduce the differences between management practices. In this study, we combined X-ray computer tomography (X-ray CT) and isothermal calorimetry to investigate the effect of soil structure on heat dissipation as an indicator for biological activity in undisturbed soil cores. Samples were collected from the topsoil of a long-term field experiment (12 years) that included four different land use systems: conventional vs. reduced tillage, each with either maize or winter wheat as the main crop in the rotation. We compared the response of undisturbed soil cores (3 cm in height, 2.7 cm in diameter) to the addition of water and glucose in specific pore size ranging in radii of 15 to 75 μm or 3 to 75 μm. The pore structure and indicators of particulate organic material were quantified using X-ray CT with a voxel resolution of 15 μm. This allowed us to distinguish between the effects of crop rotation and tillage system on the microbial activity, the soil structure and the feedback between the two. Heat dissipation correlated significantly with X-ray CT derived porosity, pore surface density, and background porosity, which were affected by both tillage system and crop rotation. These structural differences significantly increased heat dissipation in maize plots after glucose addition to the pore size range with radii of 3 to 75 μm, but not for pores with radii of 15 to 75 μm. The study showed that structural indicators can explain up to 95 % of variances in heat dissipation but only 60 % of their dynamics, here defined as 50 % of total heat dissipated. The results emphasized the importance of soil structure for microbial decomposition of soil organic matter and warrants further investigations.