



X-ray CT analyses of soil structure changes induced by agricultural machinery or different tillage practices

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The soil structure is influenced by soil management, e.g. by heavy agricultural machinery and by different tillage practices regarding depth and intensity of tillage processes. We do not know exactly the soil processes at the microscale, especially the interaction between parameters affecting soil structure in different soils, under different land use and climatic conditions. Furthermore, it is important to detect initial stages of degradation processes to react as soon as possible, with the aim to protect the soil structure against further deterioration.

Different techniques of X-ray CT analyses have been used like visual assessment of the soil structural condition through inspection of the X-ray CT images, 3D visualization of air-filled macropores, calculation of the mean dry bulk density and standard deviation of voxel-related HU values for successive structural characterisation of horizontal slices or ROI cylinders of soil cores and quantification of morphological properties of soil structure.

In this presentation, the use of X-ray computed tomography is demonstrated for studying loess soils and their structural changes as affected by heavy harvest technique, transition of conventional tillage to conservation tillage, burrowing earthworms and growing sugar beets.

The harvesting of sugar beets with the high axle load harvester “Hollmer” damaged the structure of the lower topsoil in conventional as well as conservation tillage, independently of differences in initial soil structure in the same manner.

The change from conventional to conservation tillage leads to a more dense topsoil layer below the seedbed zone, which is mainly not a barrier for plant roots. Anecic earthworm species penetrate this layer and create vertically orientated burrows with high connectivity, and could act as preferential flow paths for solute and water transport.

Earthworms compact the soil around the burrow exerting radial and axial pressures during burrowing. The maximum dry bulk density at the burrow wall decreases with increasing distance from the centre of earthworm burrow.

Sugar beets compact the surrounding topsoils and cause cracks in radial direction during their growth. Some indications were found, that the sugar beet roots try to penetrate the non-tilled bottom part of the topsoil at conservation tillage.

The use of X-ray computed tomography in soil physical studies of soil cores allows to detect and quantify the narrowly spaced morphological properties of soils. This will improve the understanding and modelling of soil processes.