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Using X-ray imaging for monitoring the development of the macropore network in a soil sample exposed to natural boundary conditions

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Soil macrostructure is not static but continuously modified by climatic and biological factors. Knowledge of how a macropore network evolves in an individual soil sample is however scarce because it is difficult to collect respective time-lapse data in the field. In this study I investigated whether it is reasonable to use X-ray imaging to monitor the macropore network development in a small topsoil column (10 cm high, 6.8 cm diameter) that is periodically removed from the field, X-rayed and subsequently installed back in the field. Apart from quantifying the structural changes of the macropore network in this soil sample, I investigated whether earthworms entered the soil column and whether roots grew beyond the lower bottom of the column into the subsoil.

The soil was sampled from a freshly hand-ploughed allotment near Uppsala (Sweden) in the beginning of June 2013. Rucola (eruca vesicaria) was sown on the top of the column and in its vicinity. When the soil column was for the first time removed from the field and scanned in October 2013, it contained four new earthworm burrows. Root growth into the subsoil was largely absent. Over winter, in May 2014, no further earthworm burrows had formed. Instead, the macrostructure had started to disintegrate somewhat. No crop was sown in the 2014 vegetation period and the soil sample was left unploughed. In October 2014, the column contained again new earthworm burrows. Furthermore, a dandelion had established on the soil column together with some grasses. Several roots had now connected the soil column with the subsoil.

The study shows that X-ray tomography offers a promising opportunity for investigating soil structure evolution, even though it cannot be directly installed in the field.