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Topsoil structure as an indicator of river restoration success

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Braided rivers were in the past one of the most typical landscapes of Swiss alpine and pre-alpine valleys. However since the middle of the 19th century, this landscape has progressively disappeared, largely due to the development of flood protection structures and water exploitation for reasons of energy and food security. In the last 20 years, the number of river restoration projects aiming to re-establish the structure and ecological functions of floodplains has increased. Nowadays, there is a lack of methodology to evaluate the success of these projects. As alluvial soils exhibit characteristics of both sediment transport and deposition, and in situ pedogenesis, we propose to use soil as an indicator of success of river restoration. Indeed, the soil morphology reflects the efficiency of the fluvial dynamic and consequently affects the diversity and characteristics of terrestrial habitats.

The effects of river widening on changes of soil morphology and especially on the humus structure are studied, by comparing a restored river area and an embanked area. The study site, named Schäuffäuli, is located along the Thur River (TG/ZH, Switzerland) and has mainly been restored in 2002. Different methods are used: soil profile descriptions, humus characterisation based on porosity measurements (porosimeter and polished slabs), structural stability (calculation of MWD), amount of organic carbon, and total nitrogen in the different sizes of soil aggregates.

A complete linkage clustering applied to the soil profile dataset (110 soil profile descriptions based on field morphological characteristics) allows the identification of 8 different morphological groups. We demonstrate that river widening deeply modifies the soil morphology, especially close to the river. The frequency of thick soils as well as soils with hydromorphic features decreases while bare soils appear close to the riverbed. Some soils, under mature forest, are not modified by the river widening. Along a vegetation gradient corresponding to time colonisation, the type of humus evolves as well as organic matter concentration. In addition, organic matter stocks increase from bare soils (carbonate-rich FLUVIOSOLS BRUTS according to the Sound Reference base for soils, 1998) to carbonate-rich FLUVIOSOLS TYPIQUES under willow bushes. These parameters decrease in humus layers of FLUVIOSOLS TYPIQUES under mature forest and pasture corresponding to the un-restored area. Along this time gradient, the type of structure evolves (from granular to polyedric) and becomes more and more widespread within the humus layer and more stable. These changes allow us to identify the sectors where river widening modifies the soil morphology and the humus layer characteristics. The river widening leads to creation of alluvial soils that favour the implantation and/or conservation of alluvial terrestrial species but the efficiency of the Thur River restoration is still restricted to sectors adjacent to the river while others sectors are not modified.