

Impact of Ecosystem Engineers on Soil Structuration in a Restored Floodplain in Switzerland

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Abstract : Numerous river restoration projects have been established in Switzerland in recent years after decades of human activity in floodplains. The success of restoration projects in terms of biodiversity and ecosystem functions largely depend on the development of the floodplain soil system. Plants and earthworms as ecosystem engineers are known to be able to build up a stable soil structure by incorporating soil organic matter into the soil matrix that creates water stable soil aggregates. Their engineering efficiency however largely depends on changing soil properties and frequent floods along an evolutive floodplain transect. This study, therefore, aims to quantify the effect of flood frequency and duration as well as of physico-chemical soil parameters on plants' and earthworms' engineering efficiency. It is furthermore predicted that these influences may have a different impact on one of the engineers that leads to a varying contribution to aggregate formation within the floodplain transect. Ecosystem engineers were sampled and described in three different floodplain habitats differentiated according to the evolutionary stages of the vegetation ranging from pioneer to forest vegetation in a floodplain restored 15 years ago. In addition, the same analyses were performed in an embanked adjacent pasture as a reference for the pre-restored state. Soil aggregates were collected and analyzed for their organic matter quantity and quality using Rock Eval pyrolysis. Water level and discharge measurements dating back until 2008 were used to quantify the return period of major floods. Our results show an increasing amount of water stable aggregates in soil with increasing distance to the river and show largest values in the reference site. A decreasing flood frequency and the proportion of silt and clay in the soil texture explain these findings according to F values from one way ANOVA of a fitted mixed effect model. Significantly larger amounts of labile organic matter signatures were found in soil aggregates in the forest habitat and in the reference site that indicates a larger contribution of plants to soil aggregation in these habitats compared to the pioneer vegetation zone. Earthworms' contribution to soil aggregation does not show significant differences in the floodplain transect, but their effect could be identified even in the pioneer vegetation with its large proportion of coarse sand in the soil texture and frequent inundations. These findings indicate that ecosystem engineers seem to be able to create soil aggregates even under unfavorable soil conditions and under frequent floods. A restoration success can therefore be expected even in ecosystems with harsh soil properties and frequent external disturbances.

Keywords : ecosystem engineers, flood frequency, floodplains, river restoration, rock eval pyrolysis, soil organic matter incorporation, soil structuration

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