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Spatial and temporal variability of soil moisture in a restored reach of an Alpine river

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In order to assess the effects of river restoration on water quality, the biogeochemical functions of restored river reaches have to be quantified, and soil moisture is a key environmental variable controlling this functionality. Restored sections of rivers often are characterized by a dynamic mosaic of riparian zones with varying exposure to flooding. In this presentation, the spatial and temporal variability of soil moisture in riparian soils of a restored reach of the Alpine river Thur in northeastern Switzerland is shown. The study was part of the interdisciplinary project cluster RECORD, which was initiated to advance the mechanistic understanding of coupled hydrological and ecological processes in river corridors.

The studied river reach comprised the following three functional processing zones (FPZ) representing a lateral successional gradient with decreasing hydrological connectivity (i.e. decreasing flooding frequency and duration). (i) The grass zone developed naturally on a gravel bar after restoration of the channelized river section (mainly colonized by canary reed grass Phalaris arundinacae). The soil is loamy sand to sandy loam composed of up to 80 cm thick fresh sediments trapped and stabilized by the grass roots. (ii) The bush zone is composed of young willow trees (Salix viminalis) planted during restoration to stabilize older overbank deposits with a loamy fine earth. (iii) The mixed forest is a mature riparian hardwood forest with ash and maple as dominant trees developed on older overbank sediments with a silty loamy fine earth.

The study period was between spring 2009 and winter 2009/2010 including three flood events in June, July and December 2009. The first and third flood inundated the grass zone and lower part of the bush zone while the second flood was bigger and swept through all the FPZs. Water contents in several soil depths were measured continuously in 30 minute intervals using Decagon EC-5 and EC-TM sensors. There were six spatial replicates for each FPZ and depth.

At all monitoring locations the occurrence of water saturation in a given soil layer could be related to river discharge and additional soil moisture peaks in topsoil to rain events. However, absolute soil moisture levels during unsatured conditions exhibited strong spatial variability in all FPZ, probably mainly due to variability in soil texture and plant cover. In addition, in the grass zone the major summer floodings changed conditions at least temporarily. On one hand, the soil's field capacity apparently increased stepwise with each flooding, which may be explained either by fresh input of fine sediments or by retarded wetting of hydrophobic microsites rich in soil organic matter. On the other hand, the dominant canary reed grass was irreversibly flattened by each flood and replaced by a new generation of small seedlings. Processes and events as those described before complicate predictions of soil moisture in highly dynamic and biologically active systems like colonized gravel bars. In addition, it has consequences for the rate of sensitive biogeochemical processes such as denitrification which is strongly affected by soil moisture.