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Hydromorphological control of nutrient cycling in complex river floodplain systems

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Riparian zones and floodplains are key components within river ecosystems controlling nutrient cycling by promoting transformation processes and thus, act as biogeochemical hot spots. The intensity of these processes depends on the exchange conditions (the connectivity) with the main channel and the morphological setting of the water bodies. At the landscape scale, three interrelated principles of hydromorphological dynamics can be formulated regarding the cycling and transfer of carbon and nutrients in large rivers ecosystems: a) The mode of carbon and nutrient delivery affects ecosystem functioning; b) Increasing residence time and contact area impact nutrient transformation; c) Floods and droughts are natural events that strongly influence pathways of carbon and nutrient cycling. These three principles of hydromorphological dynamics control the nutrient uptake and retention and are linked over different temporal and spatial scales.

All three factors can be strongly affected by natural disturbances or anthropogenic impacts, through a change in either the water regime or the geomorphologic setting of the river valley. Any change in natural water regimes will affect the biogeochemistry of riparian zones and floodplains as well as their ability to cycle and mitigate nutrient fluxes originating from upstream and/or upslope. Especially these areas have been altered by river regulation and land use changes over the last 200 years leading to the deterioration of the functioning of these compartments within the riverine landscape. The resulting deficits have prompted rehabilitation and restoration measures aiming to increase the spatial heterogeneity, the complexity, of these ecosystems. Yet, a more integrated approach is needed considering the present status of nutrient dynamics and the effects of restoration measures at different scales.

The present paper analyses the effects of river side-arm restoration on ecosystem functions within the side-arm and highlights potential effects on the main channel in a large river, the Danube River. During the growing season of 2006 and the end of the growing season 2007, a large-scale field survey was completed for two areas in the floodplain stretch of the Danube River one of which has recently undergone restoration via reconnection to the Danube River main channel. The sampling compared the sediment nutrient concentrations and potential denitrification and respiration rates. With changing surface water connection to the Danube River, the water bodies in the two compared floodplains experienced different patterns of microbial processing rates, particularly potential denitrification. We demonstrate that principles of hydromorphological dynamics control nutrient cycling in the water column and at the water sediment interface.

These findings confirm the environmental control on these processes and their potential use as proxies to assess the consequences of hydrological changes by restoration measures on river ecosystem functioning.