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Groundwater – surface water interactions and phosphorus biogeochemistry in river floodplains

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In many European lowland rivers, floodplains have been disconnected from adjacent channel systems. Consequently, the groundwater – surface water interface is largely restricted to near bed and bank sediments. However, if the river-floodplain system remains hydrologically connected, then the groundwater – surface water mixing zone may extend for hundreds of metres away from the main channel and into the floodplain. Biogeochemical processes, coupled with advective water and solute transport, indicate that floodplain groundwater may exert a strong control on surface water chemical quality. We examined the processes controlling the release of soluble phosphorus to floodplain groundwater, and the subsequent export of phosphorus from the floodplain to the river channel. We show that the release of phosphorus in submerged floodplain sediments is controlled by redox thresholds. The reductive-dissolution of phosphorus complexed at the surface of ferric hydroxide in these sediments can lead to a rapid and sustained release of phosphorus to solution. Concentrations of phosphorus in groundwater and surface water can reach several milligrams per litre. The form of phosphorus released is dominated by the readily bioavailable orthophosphate ion, indicating a potential for rapid uptake by bacteria and algae. Our research indicates that the timing of phosphorus release is inversely related to the nitrate-nitrogen concentration in river water, posing significant challenges to the integrated management of floodplains for multi-nutrient attenuation. Further hydrological and hydrochemical data show that advective transport in groundwater can export phosphorus from the floodplain to adjacent surface water bodies.