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Effects of wetland hydrology and biogeochemical processes on phosphorus dynamics in a restored wet meadow

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Water quality of Danish lakes and estuaries has continued to deteriorate due to excess phosphorus (P) loadings from agricultural areas. Compliance with the EU Water Framework Directive requires substantial reductions in diffuse P losses. Riparian wetlands are critical interfaces in the landscape, which have the potential to regulate nutrient fluxes between terrestrial and aquatic systems. Hence, restoration of wetlands on reclaimed agricultural lowland has been recognized as a possible mitigation measure towards reducing nutrient losses to the aquatic environment. Much of the research conducted on nutrient dynamics in riparian wetlands has been concerned with removal of nitrogen, while the role in regulating P has received less attention. Riparian zones can regulate P concentrations by promoting sedimentation, plant uptake and adsorption. Several results have indicated, however, that restoration of wetlands on former agricultural areas with large amounts of iron-bound P may change the riparian zone into a P source, as a consequence of reductive Fe-dissolution. The understanding of subsurface riparian processes linking hydrological and biogeochemical processes regulating P is strongly limited.

This study examines the influence of seasonal water table fluctuations, groundwater hydrology, soil lithology and biogeochemical processes on phosphate dynamics in a restored sandy lake side riparian wet meadow. The restored lake (Rødding Lake) and the surrounding wet meadows are reestablished on former agricultural areas upstream the Viborg lakes and the Nørre Å river system that discharges to the river Gudenå. The

experimental approach involves analysis of spatial and temporal patterns of dissolved reactive P, ferrous iron (Fe^{2+}) as well as other relevant redox-relevant components in combination with data of soil moisture, hydrology, sediment characteristics and redox potentials. Prior to the lake restoration a 80 m transect was instrumented with piezometer pipes at different depths for measuring hydraulic head and sampling groundwater. Additionally Pt-electrodes for measuring redox potential, TDR-probes for measuring volumetric soil-water content and temperature sensors were installed adjacent to the piezometer pipes. Sampling and measurements were carried out more than 2 years after restoration. The results reveal the interactions between seasonal variations in soil moisture, hydrologic flow paths and redox dynamics that control subsurface P dynamics in the wetland sediment.