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Eutrophication and phosphorus release of rewetted peatlands - lesson learned from Neman River basin

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Rewetting peatlands and restoring wetland buffer zones are often considered primary measures to support local biodiversity and mitigate non-point agricultural pollution loads. However, rewetting peat soils (histosols) that were previously used for agriculture, intensive grasslands, or croplands could lead to the release of soil phosphorus and cause eutrophication of soil, groundwater, and adjacent watercourses (Smolders et al., 2006; Banaszuk et al., 2011). Estimates suggest that phosphorus concentration in soil pore water of rewetted fen can be up to three orders of magnitude higher than under natural conditions (Zak et al., 2008).

Under the framework of the Interreg Baltic Sea region project "DESIRE", we estimated the total phosphorus (TP) accumulation within the topsoil (up to 50 cm in depth) in four peatlands planned for restoration in three countries (Lithuania, Poland, Russia - Kaliningrad Region) of the Neman River basin.

Results show that the long-term agricultural use of histosols may result in total phosphorus accumulation in the topsoil, ranging from 50 to over 300 g P m^2. A significant part of P consists of metal oxide compounds as redox-sensitive phosphorus characterized by variable dynamics. Soil anoxia increases after rewetting, causing reductive Fe (III) compounds to dissolve, leading to a high discharge rate of Fe (II) and P. Therefore, a significant P release is expected, which can amount to up to 6 g P m^2 (NH_4Cl_P + BD_P fractions), followed by severe ground- and surface water pollution.

The initial influx of nutrients after rewetting can be significant, and affect the expected restoration outcome (Cabezas et al., 2013). Eutrophication can support the spread of fast-growing generalist plant species, mainly Phragmites australis and Typha sp., instead of the diverse vegetation composition targeted by restoration planners (Kreyling et al., 2021). Nonetheless, these new rewetted ecosystems may provide some services comparable to pristine wetlands, and the export of nutrients by regular harvesting under paludiculture management reduces the risk of nutrient losses to open waters.

In conclusion, elevated release of P is initially expected for nutrient-rich rewetted histosols. Nevertheless, in the long run the benefits from rewetting outweigh the disservices of draining peatlands.