Effects of rewetting of peatlands on nutrients behavior are complex: preliminary results (Piotr Banaszuk)

Wetland restoration has many goals: in addition to supporting biodiversity, the ability to sequester organic carbon and restore buffer zones is indicated as the primary measure to reduce non-point agricultural nutrient loads. Unfortunately, it is widely recognized that the rewetting of wetlands on former agricultural land could potentially lead to the release of soil phosphorus and nitrogen and become a cause of eutrophication of soil, groundwater, and adjacent watercourses. Thus, instead of the expected water quality improvement, we can expect an increased pollution impulse that can last for years. However, estimating the duration of P release is complex, and the reoxidation and readsorption of P at the redox boundary should be critical environmental factors in mitigating the water pollution problem.

Triplicate peat samples from three layers 0-5, 20-30, and 40-50 cm in depth were collected from randomly selected locations in Poland, Russia, and Lithuania. Fresh sediment was subjected to sequential chemical extraction through the consecutive use of 1 M NH4 Cl to determine the loosely adsorbed P and SRP present in the pore water (NH_4Cl – P); bicarbonate-buffered dithionite (0.11 M $NaHCO_3$ / $Na_2S_2O_4$) to release the redox-sensitive P mainly bound to Fe hydroxides and Mn compounds (BD-SRP) and organic P mobilized under low redox conditions in the same fraction that may be detected after digestion (BD-NRP); 1 M NaOH to mobilize P bound to metal oxides, OH^- exchangeable P determined as SRP (NaOH-SRP), and organic bound P in the same fraction (NaOH-NRP); and 0.5 M HCl to mobilize P sensitive to a low pH bound to carbonates and apatite.

We found that the long-term agricultural use of histosols resulted in the accumulation of total phosphorus, which in the top 50 cm layer of the studied soils ranged from 50 to over 300 g P/m^2.

Anoxic conditions that will occur in the peat after restoration at low oxygen supply can cause dissolution of reductive Fe (III) compounds, leading to a high discharge rate of Fe (II) and P. As a result, a significant release of P is expected, which can amount up to 10 g P/m^2 (NH4Cl_P + BD_P), followed by severe pollution of ground- and surface waters. In addition, soil eutrophication can support the development of fast-growing generalists, mainly Phragmites australis and Typha sp. instead of desired plant composition targeted by restoration planners.

There is a clear relationship between habitat pH and the C: N ratio and the amount of phosphorus potentially released. For example, in habitats where the pH is close to neutral, the amount of mobile phosphorus (NH4Cl_P + BD_P+ NaOH_P) may reach 60 g/m^2, while in acid, raised bogs, the potential release does not exceed ~ 10 g/m^2. In addition, a clear relationship was found between the C: N ratio and the mobile P. Thus, two parameters C: N and pH, could be successfully used as a proxy to assess the phosphorus eutrophication potential of rewetted peatlands.

Eutrophication of the habitat can, on the other hand, positively affect the potential of paludiculturte: the cultivation of biomass for various economic purposes. The removal of nutrients along with harvested biomass in the perspective of decades may return the ecological balance and restore the previous mesotrophic/eutrophics conditions of the habitat, with all the abundance of ecosystem services.