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Editorial

Restoration of Wetlands – a Challenging Opportunity to Reduce Water Pollution

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According to the Ramsar Convention on wetlands (*UN Treaty Series No. 14583*), two thirds of the world population exists on dependence upon wetlands. Wetlands have been known as the areas that are saturated with water, either permanently or periodically, and support the growth of aquatic plants. They have been recognized as biotopes able to feed downstream waters, trap floodwaters, recharge groundwater supplies and provide wildlife habitat. Wetlands are zones of transition between terrestrial and aquatic habitats. The specific water circulation and chemical exchange regimes predetermine the development of specific plant and fauna communities in wetlands. The value of diversity found in wetlands is very significant. Many wetland habitats are valuable and preserved on a global scale. About one third of valuable habitats of Lithuania are also found in wetlands.

Pollution of surface water with an excess of nutrients (predominantly nitrogen and phosphorus) still remains a big issue of environmental concern. Wetlands, among many other ecological functions they perform, are distinguished by their ability to treat contaminated water by natural means. There is a wide range of physical, chemical and biological processes within a wetland that enable water purification. Unfortunately, despite of the great ecological value, the most part of wetlands has been destroyed or degraded worldwide. Therefore, seeking for a new approach in river basin planning, restoration of wetlands could benefit from the improved quality of waters. Also, it can be essential to ensure ecological integrity, and to some extent it can reduce the impact of climate change.

Transformation of wetlands by human activity gained momentum in the second half of the 19th century, when land drainage was carried out and the demand for peat as an energy source grew up. In almost one hundred years of land reclamation in Lithuania, the total area of drained land has reached 3.021 mln. ha (47 % of the country's area) including 2.620 mln. ha reclaimed by tile drainage. Land reclamation has significantly reduced biodiversity and subsequently increased the inflow of nutrients to rivers and lakes. The area of bogs and other natural habitats in the drained territories has been rapidly shrinking followed by extensive transformation to agricultural land. Due to land drainage activities in 1955–1995 almost 50 000 ha of wetlands were lost. These changes have adversely affected water quality by the enrichment of nutrients in rivers and lakes.

Since the restoration of Lithuania's independence in 1990, fundamental changes in the sectors of agriculture and industry have taken place. In agriculture, the rising costs for energy and chemicals have conditioned reduced application of fertilisers. One might expect that this should result in a corresponding decrease in riverine loads of nitrogen and phosphorus, however, it did not happen. This is explained by the fact

that the inflow of nutrients is of inert character. It is predetermined not only by human-induced but also by natural factors such as chemical properties of soils, soil humus content, wet deposition, mineralization of organic matter, land cover, etc. These findings point out that natural barriers aiming to retain nutrients in river basins are highly necessary, and restoration of wetlands is quite likely to contribute to the creation of the barriers.

According to the recent studies, the demand of wetland area to the existing one in Lithuania makes 0.74% of the total territory (except the Curonian Lagoon). Wetlands are most necessary for the North, Middle and South-West Lithuanian river basins. This mainly concerns the basins of small tributaries of the Nemunas, Lielupė, Dubysa, Venta, Mūša, Nemunėlis, Nevėžis, and Šešupė rivers. In total, there are 114 river basins where riverine concentrations of total nitrogen are too high, 9 basins with too high concentrations of total phosphorus and 44 river basins are distinguished for high values of BOD.

Hydrology takes a key role in wetland functioning. Relevant hydrological conditions are an important factor in the efficiency of nutrient retention in wetlands. It is of great importance that wetlands do not dry up in drought periods. Due to increased mineralization, dried wetlands may release nutrients instead of retaining them. To preserve the retention capacity, wetlands must always be kept water saturated. Water residence time and water depth in a restored or newly created wetland are the major characteristics predetermining the retention of nutrients. It has been estimated that for retention of more than 50% of dissolved forms of nitrogen and phosphorus, the water residence time in a wetland must be at least 7 days and the ratio between the total area of wetland to the basin area must be not less than 4–5%. A critical limit of wetland area in the river basin is 0.05%.

There are many ways and procedures how to restore wetlands. In the case of Lithuania, the priority has to be given to the areas where drainage systems have failed or have worn off, as well as to abandoned or not valuable agricultural land. For reduction in the inflow of nutrients from the farmlands, conventional drainage systems can be transformed into controlled drainage systems. This measure could help to reduce the annual outflow of dissolved nitrogen and total phosphorus compounds by 30 to 95%. The introduction of controlled drainage would be most expedient in loam and clay soils (where the portion of clay fraction accounts for less than 15%) with ground surface slope not more than 2%. Yet the simplest way to form wetlands is to damage the drainage lines or destroy the watercourses of surface runoff. However, this measure could be applied only to the achievement of very specific environmental purposes (e.g., restoration of bird habitats, and the like).

Wetlands can also be created by widening the cross-sections of drainage ditches at the mouths as well as by redirecting some of the river runoff into the floodplain and creating backwaters, or by connecting the main riverbeds with oxbow lakes. Desolated areas of winter and summer polders and fish breeding reservoirs are also suitable for creation of wetlands.

It is possible to eliminate the adverse effects of drainage and raise the groundwater level in disturbed wetlands (mainly in drained raised peat bogs and intermediate bogs) and surrounding areas by the damming of drainage ditches. For this purpose, walls of different type and small earth dams can be used.

An increase in beaver (*Castor* spp.) population could be an important factor for creation of wetlands. Today, drainage ditches are the habitat of the main part of beaver population in Lithuania. Even 36% of the total investigated habitats (active and abandoned) of beavers were found in drainage ditches across agricultural fields, forests and forest outskirts. Beaver habitats in large natural rivers account for 18% and in lakes for 16.5% of the total. Many beaver habitats were also found in various types of wetlands (14.6%). Supposedly, the current beaver population in the network of drainage ditches amounts to at least 17–18 thousand individuals. The length of the stretches of drainage ditches, which are dammed by beavers, accounts for 14% of the total. By "constructing" dams and creating ponds, beavers change the surrounding environment by transforming it into their living habitat. As a result of hydrological (water levels and runoff volume), geomorphological (channel shape and slope, accumulation and transport of sediments), physical (bottom structure, flow rates, water transparency and temperature) and chemical (nutrients, pH and redox reactions) properties of water, the change and transformation of various substances take place. The research carried out in the Middle Lithuanian Nevėžis River basin has revealed that beaver ponds on average retain 28% of inorganic N and 43% of inorganic P compounds. However, despite of the increased nutrient retention value, beavers are welcome in the areas where their activity is not in conflict with land drainage in intensively cultivated agricultural land.

According to different literature sources, soil particles, phosphorus and nitrogen leaving the river basins are reduced during passage through the wetlands by 50-75%, 20-95% and 3-50%, respectively. This apparently demonstrates that wetlands have a great potential to retain large amounts of N, P and organic matter and to protect surface and groundwater from being polluted. However, even restoration of wetlands seems to be a step in the right direction, it can only be regarded as a supplement to other practices, and not as the solution to all water quality problems.

The EU Water Framework Directive (WFD) aims to provide a new approach to the EU water policy to protect surface and groundwater from human activities. It requires Member States to prevent any further deterioration in the health of their waters, and importantly has a general objective for water ecosystems to restore their functioning and biodiversity. Restoration of wetlands well corresponds to the goals of the WFD. Wetlands are not "waste lands", even this opinion has been alive during centuries. Wetlands should be considered as valuable assets for human health, safety and welfare. The preservation of wetlands should be based on the "wise

use" concept. In modern world, the wise use of wetlands is generally defined as the maintenance of their ecological character within the context of sustainable development for the benefit of humans.

The main environmental risk of restored wetlands is likely increased emissions of greenhouse gases, particularly methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2). However, the latest calculations reveal that the global influence of wetlands on climate change is insignificant. S.Teiter and U.Mander from Tartu University have estimated that even if all global domestic wastewater were treated by wetlands, their share of the gas emission budget would be less than 1%.

There is a strong belief that our change of thinking will improve many of the things that currently threaten wetlands. Famous American dramatist Edward Albee wrote:*" Sometimes it's necessary to go a long distance out of the way in order to come back a short distance correctly*."

The time has come to learn from mistakes! Good luck in restoring wetlands!