EDITORIAL

Fit-for-Purpose Water in the Baltic Sea Region

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Climate change is visible everywhere, including in Baltic Sea Region (BSR). One of the symptoms is water scarcity, occurring relatively locally but persisting over longer and longer periods. The European and Global Drought Observatories (https://drought.emergency.copernicus.eu) present increasing BSR areas where soil moisture is alarmingly low. Water shortages cause technical and organizational problems in water utilities, agriculture, energy, industry, etc. Hence, competition for water between industry, agriculture, and municipal services has emerged. Sustainable water resource management requires solutions that rationalize and optimize the use of available resources with particular care for the environment. One of the methods of remedying local problems is closing local water and nutrient cycles by recovering water from urban wastewater and using rainwater.

Access to tap or underground water is familiar and straightforward in the region. Therefore, this water is used for very different purposes, even though its quality does not correspond to, and in most cases significantly exceeds, the requirements related to a specific application. Drinking water is not the best way to water plants because it contains too few nutrients and requires additional artificial fertilizers. Industry, on the other hand, often must use additional treatment. Washing the streets with drinking water is extravagant.

Used tap water is discharged to wastewater treatment plants after a single use, even though a lot of energy and human labor costs have been put into it. As early as 1991, the Urban Wastewater Treatment Directive (91/271/EWG) emphasized the importance of treated wastewater reuse. This trend is reinforced by the new directive.

Some solutions enable the recovery and reuse of water from wastewater. Wastewater treatment plants are, therefore, no longer linear plants and are becoming bio-factories recovering raw materials, energy, and water from wastewater.

In the Baltic Sea region, water recovery from urban wastewater seemed unnecessary, but the climate crisis and changes in the local water balance have influenced the search for new solutions. The results of the ReNutriWater project (https://interreg-baltic.eu/project/renutriwater/) survey indicate that wastewater treatment plant operators see the potential for recovery but also the risks arising from the quality and reliability of the reclaimed water consumer. Many wastewater treatment plants recycle wastewater for internal technological needs, i.e., cleaning equipment. Only a few broader solutions have been implemented in Poland, and the recovered water is used to wash streets or cool power plants.

Therefore, initiatives involve technological projects and business models integrated with risk assessment. Finding a recipient and adjusting the reclaimed water quality to its needs is a significant challenge.

Risk assessment is extremely important in recovery projects. Risk management in water management is not a new issue. However, the methodology must be adapted to the city's specific needs regarding reclaimed water use. There are ISO standards and European, Australian, and American guidelines, especially in regions where the agricultural use of water recovered from wastewater is not a new idea. In Europe, implementing the EU Regulation 2020/741 on water reuse in agriculture is causing many emotions, and its implementation is very diverse. However, most Member States face organizational, financial, political, and psychological barriers to implementing this legislation and solutions based on the use of water reclaimed from wastewater. In the Baltic Sea Region, agricultural use is not the main direction of reclaimed water use. This is where solutions for the urban fabric come in: irrigation of green areas, recreational areas, street washing, etc.

Therefore, it is necessary to focus on producing water of such quality that can meet specific local needs, for example, containing enough nutrients to replace at least some artificial fertilizers. The ReNutriWater project matched water quality to needs by controlling nutrient removal at the MBR plant (*Table 1*).

Properly removing microbiological and physicochemical contamination is an important aspect. In fit-for-purpose water production, standards and values that are necessary but that will not lead to an undue burden on operators, leading to unprofitable recovery projects, should be included in the risk assessment. The European Commission's Guidelines for agricultural risk assessment (2022/C 298/01) describe recovery for agricultural purposes in detail, focusing on qualitative, quantitative, and technological issues. Some of the tasks are beyond the needs of small applications but contain many guidelines that may be useful in urban applications where plant irrigation is involved. However, they are very broad, hence the need to adapt them to local needs.

Once hazards and hazardous events have been identified through risk assessment, a risk management plan should be developed to minimize potential negative impacts on end-users and the environment. A risk management plan describes how the maximum inherent risks for a particular application are managed and what controls should be implemented to reduce residual risks to a minimum or acceptable level.

After selecting dangerous events that require additional control with maximum risk, it is undertaken to develop tasks that will reduce risk. This can be a monitoring procedure, additional analyses, operating instructions, an internal communication plan, etc. Management and communication procedures are essential in both standard and incidental conditions and in emergencies.

Water recovery focuses mainly on technical aspects related to the reliability of technology and infrastructure and monitoring of the quality of reclaimed water. However, in risk management, it is impossible to ignore the social aspects related to building public awareness and trust of consumers in suppliers of reclaimed water and products produced using this water. Strategies related to the transparency of pilot projects are, therefore, crucial from the beginning of the local solutions process.

Table 1. *Efficiency of controlling nutrient removal in the MBR treatment plant; source: Schwander Polska (www.schwander.pl)*

Date	Technological sequence 1 (without nutrient reduction)		Technological sequence 2 (with nutrient reduction)		Tap water	
	Total nitrogen (mg/L)	Phosphorus (mg/L)	Total nitrogen (mg/L)	Phosphorus (mg/L)	Total nitrogen (mg/L)	Phosphorus (mg/L)
02.10.2023	23.87	6.89	11.34	0.68	3.75	0.41
06.10.2023	27	8.98	12.08	1.1	3.69	0.55
09.10.2023	24	10.11	11.98	1.5	3.87	0.53
12.10.2023	19	9.09	8.95	2.01	3.98	0.44
16.10.2023	22	12	11.12	2.76	4.01	0.51
19.10.2023	26	11.65	12.01	1.7	3.98	0.58
23.10.2023	32	10.98	13.76	1.08	3.89	0.71
27.10.2023	35	11.76	14.01	1.56	3.81	0.87
31.10.2023	33	11.99	13.98	2.2	4.09	0.86
03.11.2023	31	11.05	13.45	1.8	4.11	0.82

The narrative of water reuse is often seen as a need to manage conflicting emotions. The complex interplay between technological, economic, and socio-political factors shapes the successes and failures of water reuse programs. We are dealing here with the concept of the yuck factor. The term was first used by Arthur Caplan, a bioethicist, and then popularized by Leon Kass, an American physician, in 1997 in the context of bioethics discussion. The yuck factor refers to emotions and aversions related to substances or processes.

Water recovery and reuse include negative feelings associated with water previously used in households, industry, or agriculture, as well as water produced from human excrement. Emotional responses to recycled water are related to our cultural classifications and the level of social development. A key element in overcoming the yuck factor is effective communication and education of the public about water recovery processes. Explaining the environmental and economic benefits can change negative perceptions. To overcome the yuck factor, we need to not only understand the science behind technologies but also change the social and cultural values that influence our attitudes towards them.

Water production from wastewater is the future of the BSR affected by climate change. Wastewater treatment plants and cities are a crucial element in the success of solutions. A risk management plan for fit-for-purpose water production must include many threads, not only qualitative, but also organizational, business, social, and mental. In addition, the solutions must be as simple as possible while remaining safe.