Wastewater Reclamation
- Opportunities, Challenges, and Barriers

M. Zubrowska-Sudol*, K. Ramm*, A. Knap-Baldyga*, K. Sytek-Szmeichel*, J. Czajkowska*, M. Wojciechowska, M. Smol*****

* Faculty of Building Services, Hydro and Environmental Engineering, Warsaw University of Technology
(*E-mail: monika.sudol@pw.edu.pl*)
** Savonia University of Applied Sciences
*** Mineral and Energy Economy Research Institute of the Polish Academy of Sciences

INTRODUCTION

Water scarcity is a phenomenon that occurs when water demand exceeds the water supply and the availability of natural water resources falls below 1000 m^3 per person per year (Kumari U. et al., 2021). Its occurrence may be due to natural causes, such as droughts, or be a result of human activity (e.g. desertification). However, it most often commences as a result of rapid population growth, urbanization, and poor resource management coupled with environmental factors (Bond N.R. et al., 2019). Unfortunately, water scarcity is a pressing global issue, affecting numerous communities worldwide. **Fig. 1** presents the global distribution of regions affected by water stress (Ritchie H. and Roser M., 2019). In 2022, more than 2 billion people lacked access to safely managed water, and projections suggest that this problem will worsen due to climate change, population growth, and increasing water demand (Kehrein et al., 2021; UN DESA, 2023). The global nature of water scarcity and its profound impact on human well-being and natural ecosystems underscore the urgent need for action. It is imperative to implement solutions that enable responsible and sustainable water management to alleviate the effects of water shortages. Among these solutions, water reuse stands out as a pivotal strategy for easing the strain on water resources (UN-Water, 2021).

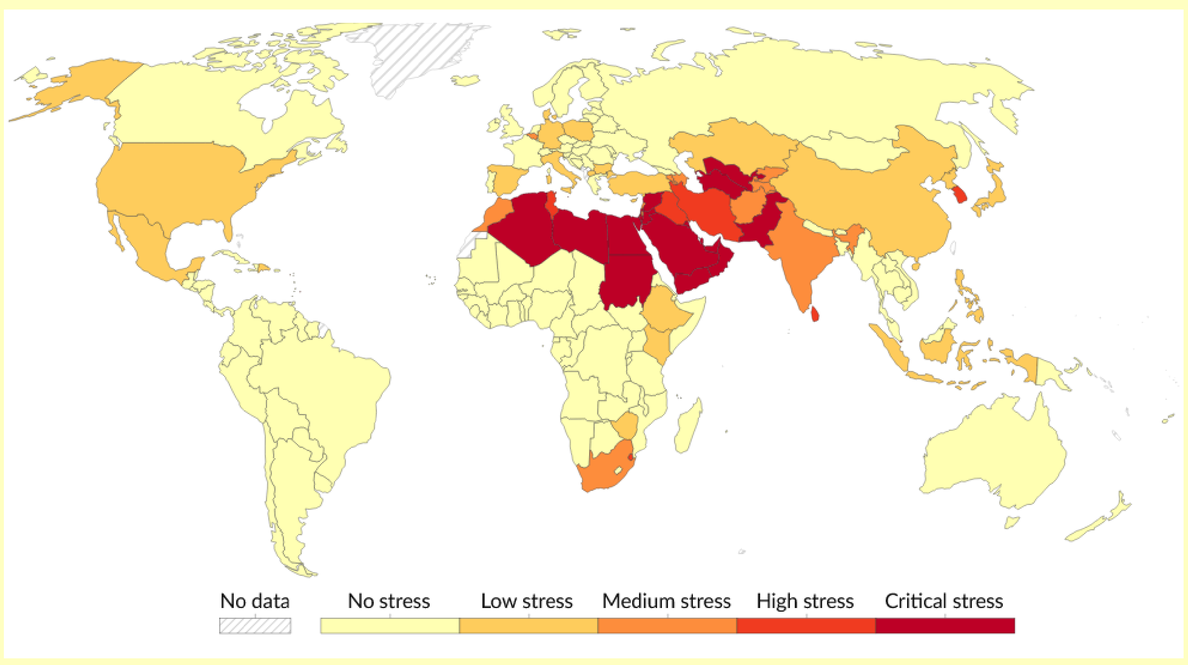

Figure 1. Levels of water stress by countries in 2019 [%] (Ritchie H. and Roser M., 2019)

OPPORTUNITIES

Undoubtedly, there is a growing need for solutions addressing the issue of freshwater shortages and providing both sustainable and accessible water supply in the future. Such solutions include municipal wastewater reclamation, which is tapping into the potential of turning hazardous waste into a valuable resource. The essence of water recovery is to eliminate contaminants within 0.1% of substances that are not water **(Fig. 2)**. Due to the different characteristics of wastewater treated, the methods of removing contaminants should be selected to suit local conditions and its surroundings. Water recovery technologies vary widely, and several processes are usually combined and selected for a specific purpose of water use. When choosing a technology, it is essential to consider three main aspects: 1) ecological, 2) economical, 3) regulatory. Well-selected technology removes various pollutants, including micropollutants (heavy metals, pharmaceuticals, pesticides, biocides, perfluoroalkyl substances, and microplastics). It also allows for the destruction of living and spore forms of pathogenic organisms and prevents their secondary development. Simultaneous recycling of water and nutrients is also possible, i.e. selecting the amounts and chemical forms of nitrogen, phosphorus, and potassium.

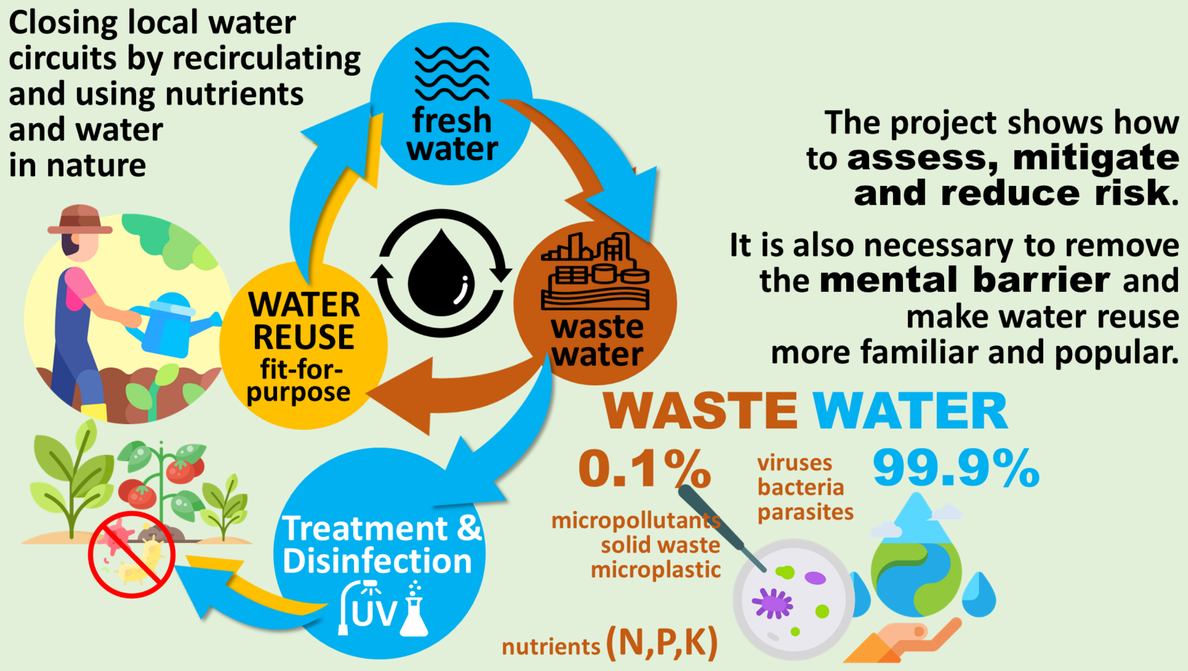

Figure 2. Closing local water circuits by recirculating and using nutrients and water in nature

CHALLANGES & BARRIERS

Despite the potential benefits, challenges remain in implementing water recovery from municipal wastewater. While many wastewater treatment plants (WWTPs) close internal circuits or use treated wastewater in plant processes, external usage, such as street washing or public green area irrigation, remains unpopular. Overcoming social acceptance barriers and ensuring the fit-for-purpose treatment of reclaimed water are essential challenges. The ReNutriWater project evaluates the feasibility of reclaimed water use based on local WWTP Conditions **(Fig. 3),** highlighting the challenges faced in water recovery from municipal wastewater.

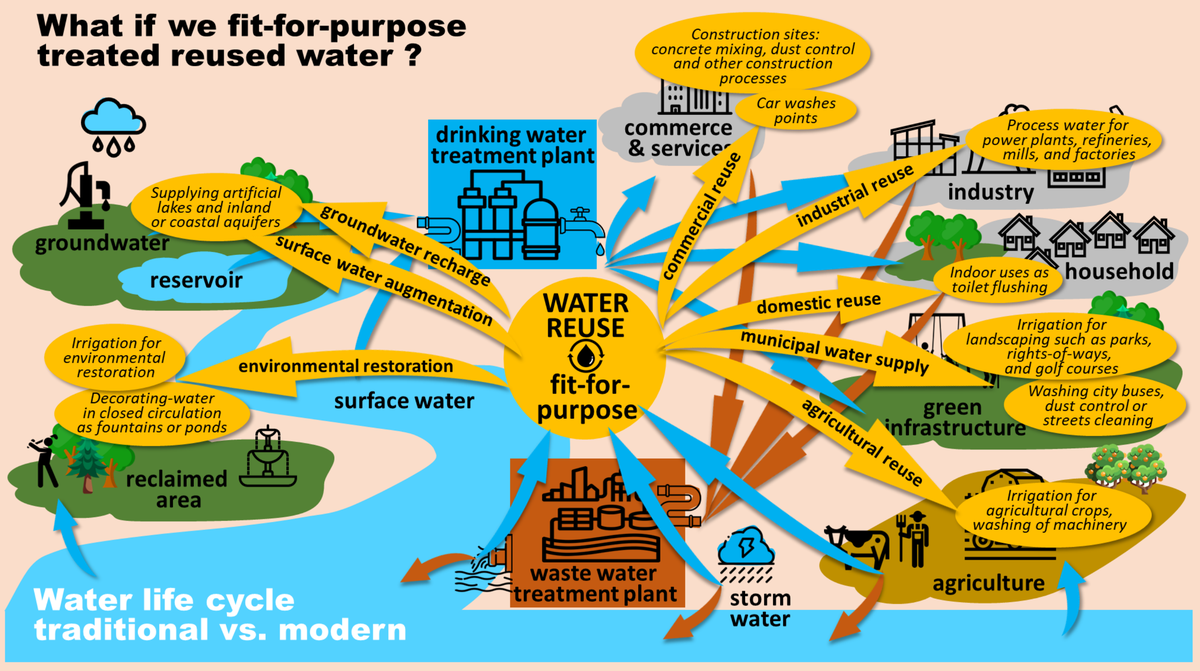

Figure 3. Fit-for-purpose treatment water reuse - modern water life cycle in Circular Economy

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SUSTAINABLE WATERS ReNutriWater
Faculty of Building Services, Hydro and Environmental Engineering
Warsaw University of Technology
SAVONIA University of Applied Sciences
WATERLAB
Mineral and Energy Economy Research Institute
Polish Academy of Sciences