

# SUSTAINABLE TRANSITION IN URBAN WATER MANAGEMENT: THE CONTRIBUTION OF URBAN WATER COMMUNITIES



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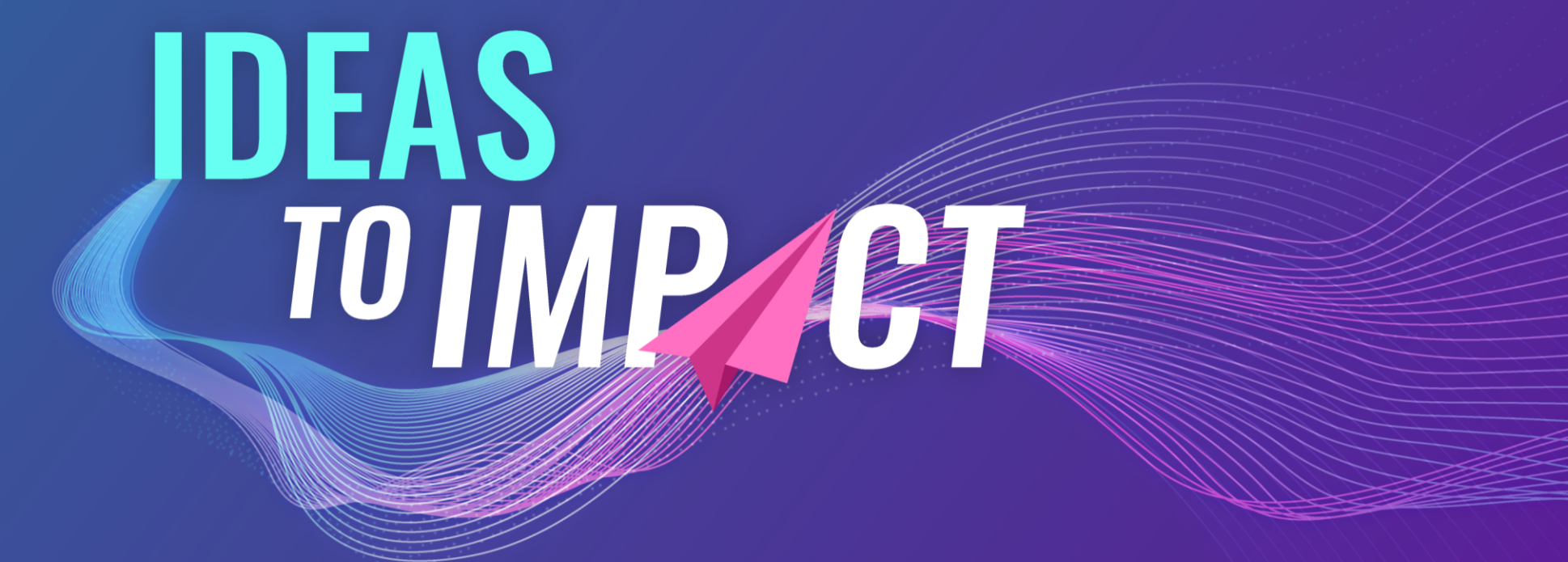
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## Abstract

In a scenario of increasing freshwater scarcity and climate change, the efficient management of water resources is essential for urban sustainability. This research explores innovative approaches to optimising water use, highlighting water efficiency, nature-based solutions (NbS) and the circular economy as key pillars. An innovative model is proposed that integrates decentralised and flexible solutions to balance the supply and demand of non-potable water, especially in regions affected by prolonged droughts. The transition to Nearly Zero Water Buildings (NZWB) and Urban Water Communities (UWC) appears to be a promising strategy to promote more resilient and sustainable solutions. The analysis focuses on the use of alternative sources, such as greywater and rainwater, and highlights the importance of clear technical parameters for the effective implementation of these approaches.

**Keywords:** urban water resilience; water efficiency; water reuse; nature-based solutions; integrated water management; sustainable cities.

## From Nearly Zero Water Buildings to Urban Water Communities

Water is a vital and finite resource, making its sustainable management essential for future generations. We face a growing demand for freshwater, while the development model in urban areas is geared towards exploiting resources such as energy, water and food. This challenges us to provide clean and safe water to meet all needs in increasingly complex ways. Climate change exacerbates the uncertainty of rainfall patterns and water availability, emphasising the need for efficiency and resilience in water management. Recently, there has been a growing interest in solutions that promote water efficiency, based on the principle of the "5Rs" [1]: reduce consumption and losses/waste, reuse and recycle water, and resort to alternative sources.

NZWB, like almost zero-energy buildings, aims at the efficient and circular use of water and is a concept that should be pursued particularly in isolated buildings. However, in urban environments, the generalization of this concept to UWC reveals significant gaps in knowledge. In urban environments, the generalisation of this concept to UWC requires a personalised approach, considering the minimum quantities necessary for each use and addressing the water quality requirements for each specific use, taking into account local consumption habits. The separation at the source of wastewater (urine, faeces, greywater) and rainwater offers opportunities for efficient and economic recovery of resources (Table 1), avoiding their loss and unnecessary investments in treatment. Rainwater harvesting and greywater reuse, in particular, are promising practices for NZWB and UWC, but in many countries, they lack defined regulations, guidelines and quality standards.

Resource recovery throughout the water cycle is an important sustainability factor, reducing costs, energy consumption and emissions. There are several sustainable solutions and technologies available, such as NbS that support decentralised water treatment and reuse [2, 3], compact water treatment systems for residential use that enable significant savings in drinking water (up to 45%) by recycling greywater [4] and, at the limit, water desalination that is effective in regions near the sea with limited access to freshwater [5]. In the circular economy, wastewater becomes valuable [6]—see Figure 1. Light greywater (washbasins, showers and bathtubs) requires less treatment than the combined wastewater stream, making reuse economical. Flow separation and specific treatment are attractive for decentralised solutions because they are close to the source of the effluent [6]. Although there are no specific regulations, it is important to take into account the minimum quality requirements (chemical/microbiological parameters), types of treatment (physical, chemical or biological), and the balance of the recycled water supply (water balance), to reduce the use of the public network [7].

Table 1 – Waste segregation and possible utilization options. Adapted from [6].

Substances	Blackwater: Urine	Blackwater: Faeces	Greywater	Rainwater
Treatment	Hygienisation by storage or drying	Anaerobic digestion, drying, composting	Constructed wetlands, gardening, wastewater ponds, biological treatment, membrane technology	Filtration, biological treatment
Utilisation	Liquid or dry fertilizer	Biogas, soil improvement	Irrigation, groundwater recharge or direct reuse	Water supply, groundwater recharge

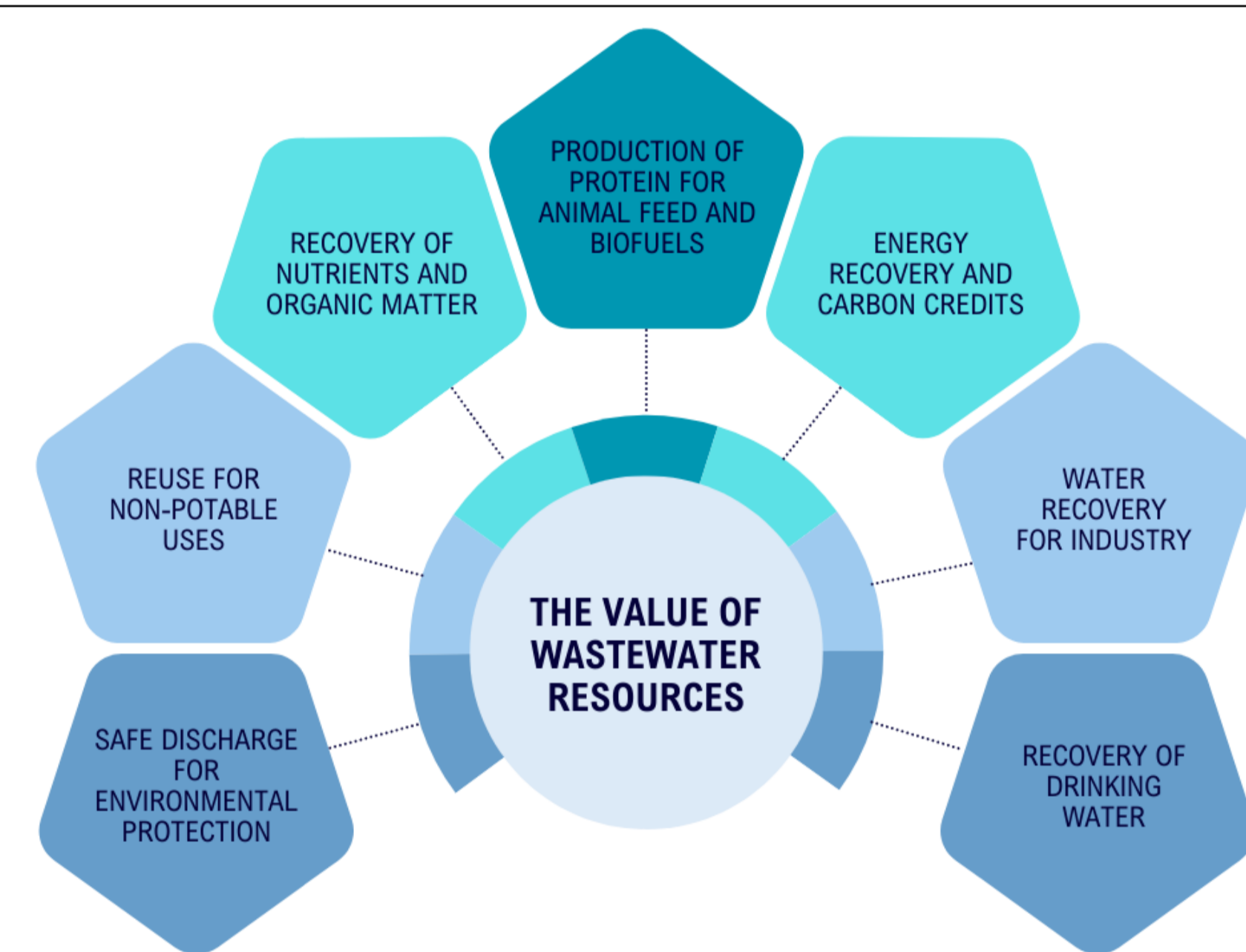


Figure 1 – Wastewater as a resource in the urban water cycle. Adapted from [7].

Sustainable water management is key to meeting contemporary challenges, and the transition to UWC is a promising approach. This transition embraces new paradigms of the urban water cycle and considers the transversal dynamics that govern the sector. Preliminary results indicate that actively controlling water losses significantly improves the efficiency of urban networks [8]; the implementation of NbS for stormwater management stands out for its multifunctionality, contributing to natural water retention, pollution reduction, aquifer recharge and the improvement of urban aesthetics and biodiversity [2, 3]; and it is essential to address knowledge gaps and establish appropriate regulations for this transition [7].

This approach not only brings economic and environmental benefits, but also increases the resilience of cities to climate change, aligning with the Sustainable Development Goals (SDGs) approved by the United Nations, especially SDGs 6, 11, 12 and 13. Cooperation between all stakeholders will be crucial to ensure the sustainability of water resources for future generations. This research is aligned with the mission of MIT Portugal 2030, focussing on water efficiency and water scarcity in the context of climate change. It has the potential to influence public policies in Portugal and serve as a model for other regions, promoting cities that balance urban growth and resource conservation, ensuring a more sustainable future.

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