

Impacts of Water Efficiency in Buildings on the Urban Water Cycle



Sara Caroline Bona

sara.cbona@ua.pt

Supervisor(s): Armando Silva-Afonso^{1,2}, Ricardo Gomes³, Hugo Rodrigues¹

1. RISCO—Research Center for Risks and Sustainability in Construction, Department of Civil Engineering, University of Aveiro
2. ANQIP—National Association for Quality in Buildings Services, Civil Engineering Department, University of Aveiro
3. INESC Coimbra and SMAS de Leiria, Department of Civil Engineering, Polytechnic of Leiria

MIT Portugal 2023 Annual Conference

ABSTRACT:

Water efficiency has an increased relevance in the current climate change context, establishing great potential in the adoption of water management best practices, namely to face the increase in water scarcity and water stress. By promoting the efficient use of water in buildings and recognizing this practice as a critical factor for environmental sustainability and for the achievement of goals established at international and national level, the main objective of this research is to assess the impacts of reduction consumption in buildings in urban water supply and drainage systems. The optimization of water use translates into a reduction in the volume of water abstracted and wastewater, with consequences that may affect the hydraulic and sanitary performances of systems. Therefore, to plan the investments, ensure the correct functioning of the public networks and environmental protection it is important to study the impact on existing infrastructures and possible mitigation measures.

Keywords: Sustainability; Water Efficiency; Urban Infrastructures; Urban Water Cycle

OBJECTIVES:

Currently, there has been an increase in the importance attributed to water efficiency, and several studies have been carried out to develop sustainable measures with the objective of safeguarding water resources and increasing the resilience of populations when facing water scarcity. The main measures to promote the efficient use of drinking water in buildings promote significant reductions in the consumption of water and associated energy, given that the abstraction, water treatment, transport and water distribution (as well as the transport and wastewater treatment) are operations with a high consumption and energy cost. To support the implementation of large-scale efficiency best practices, it is important to assess the order of magnitude of potential consumption reductions and their impacts on urban systems, since this change in water flows or volumes in infrastructure can affect their performance, the water quality, the mode and the particles' capacity of transport and the conditions of hydraulic flow of the existing systems.

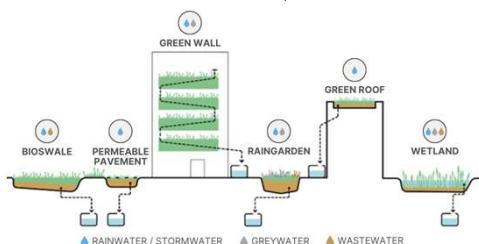
Main objective:

- to study the economic and environmental impacts of the water consumption reduction at the level of urban water supply and sanitation systems,
- to prevent problems and maintenance costs, that may arise as a result of the application of water efficiency measures in the urban environment,
- to contribute with the orientation of future public policies in the water sector, regarding their respective conditions and limitations.

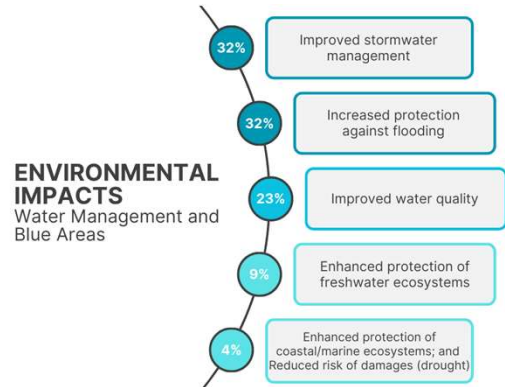
To achieve these objectives, the work will be developed in direct partnership with water companies, water users and public institutions with intervention in Portugal.

DEVELOPMENT OF SMART AND SUSTAINABLE CITIES:

- Hydraulic and sanitary systems have structural and essential importance to guarantee public and environmental safety.
- The water sector has significant potential to become more resource efficient and much more circular than it is today.
- The integration of Nature-based Solutions (Nbs) techniques in water cycle management promotes circular water systems and contributes to alternative water sources, management of large volumes of stormwater, and recharge of groundwater.
- These technologies can be used specially in Mediterranean countries where water scarcity is increasing and extreme weather events are more frequent.



Examples of types of circular water NBS and non-conventional water sources in urban areas
Adapted from: Tsatsou et al., 2023. <https://doi.org/10.1016/j.jclepro.2023.136325>.



Environmental impacts of implemented Nature-based Solutions projects in cities.
Adapted from: Bona et al., 2023. (Proceedings of the CEES 2023).

RELEVANCE TO THE MISSION OF MIT PORTUGAL:

This research is innovative considering the current low existing knowledge about the direct impacts of efficient use of water on the existing infrastructures of water and wastewater in the context of the urban water cycle. Hydraulic and sanitary systems have a structural and essential importance for the progress of society and to guarantee public and environmental safety. In recent years, Portugal has demonstrated an innovative capacity in developing smart solutions and promoting sustainable thinking regarding water efficiency measures. Water efficiency is a pressing issue and presents alternatives for cities through reduction of water consumption and, above all, its waste, but also through the use of rainwater and/or greywater. The adaptation of public water and sanitation services, in the context of the water efficiency of buildings, achieve greater resilience of systems to face climate change in Portugal, as the country is geographically located in one of the regions of the planet that most affected by climate change (Europa Meridional - Southern Europe).

This work aims to contribute to the risk prevention in terms of the performance of urban infrastructures, resulting from the reduction of water flows in those networks following the implementation of water efficiency measures in buildings. In the current economic and environmental situation, it makes sense to think of cities in order to guarantee their essential functions, their efficiency and the future of the next generations. This research is directly related to the MIT Portugal's 2030 mission to foster continuous action in favor of the development of smart and sustainable cities, aligning environmental, economic and social prosperity, as well as improving urban planning and its management so that these spaces are safer and more resilient.

BIBLIOGRAPHIC REFERENCES:

- [1] Tsatsou, A.; Frantzeskaki, N.; Malamis, S. 2023. "Nature-based solutions for circular urban water systems: A scoping literature review and a proposal for urban design and planning", Journal of Cleaner Production, volume 394, <https://doi.org/10.1016/j.jclepro.2023.136325>.
- [2] Bona, S.; Silva-Afonso, A.; Gomes, R.; Matos, R.; Rodrigues, F. 2023. "Nature-Based Solutions in Urban Areas: A European Analysis", Published on Applied Sciences 13, no. 1: 168. <https://doi.org/10.3390/app13010168>.
- [2] Bona, S.; Silva-Afonso, A.; Gomes, R.; Rodrigues, F. 2023. "Nature-based Solutions for Sustainable Urban Water Management: Addressing the Challenges in Urban Areas", Proceedings of the 2nd International Conference on Construction, Energy, Environment & Sustainability (CEES 2023), 27-30 June 2023, Funchal—Portugal.
- [3] Bona, S.; Silva-Afonso, A.; Gomes, R.; Pimentel-Rodrigues, C.; Rodrigues, F. 2022. "Higher Education Institutions in the Sustainable Transition: A Study at the University of Aveiro", Proceedings of the 7th Water Efficiency Conference (Water Resources Resilience for Small Island Developing States), Tota-Maharaj, K., Charlesworth, C., Ekwue, E. (Eds.), Trinidad and Tobago, UK: University of Bath, 14—16 Dec. 2022, pp. 170-179.
- [4] Bona, S.; Silva-Afonso, A.; Gomes, R.; Rodrigues, F. 2023. "Strategic Plan for Water Losses Management in Water Supply Systems", Proceedings of the 3rd International Conference on Water Energy Food and Sustainability (ICoWEFS 2023), May 10-12, 2023 | Leiria, Portugal.
- [5] S. Bona, and R. Gomes, "Potential for the Use of Rainwater in Higher Education Institutions: A Case Study of Building D of Campus 2 of the Polytechnic of Leiria". In conference proceedings ebook, 1st International Conference on Water Energy Food and Sustainability (ICoWEFS2021), Leiria (Portugal), 10-12 may. DOI: 10.1007/978-3-030-75315-3_79.
- [6] A. Silva-Afonso, "Building rainwater harvesting systems. Doubts and certainties", 35th CIB W062, Dusseldorf-Germany, 2009.

Funded by:



under the Doctoral Grant 2021 MPP2030-FCT | MPP research area: Sustainable Cities