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From the reservoir to the city: A contribution to promote the sustainable use of water

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Extended Abstract

The management of reservoirs, classified as heavily modified water bodies by the Water Framework Directive (Directive 2000/60 of 23 October, amended in 2019), aims to achieve their good or very good ecological potential. However, the intense water use by human populations causes accentuated water level fluctuations, contributing to the disruption of the reservoirs´ littoral zone and to an accentuated increase in nutrients and suspended organic matter in the water column and preventing the achievement of good ecological potential (Moss, 2008). Besides, when a reservoir is used for urban water supply its reduced ecological potential can impact negatively the costs of water treatment supported by municipalities. Therefore, measures preventing water waste can be one of the ways to avoid large water level fluctuations in the reservoirs, allowing the achievement of the good ecological potential. Examples of these measures include: (1) assess which activities consume the most water; (2) evaluate and implement the water efficiency use and (3) implement, when possible, water reuse (4) investigate the occurrence of *water* loss through leakages.

Serra Serrada (S. Serrada) is located on Natural Park of Montesinho (NE Portugal; latitude: 47º57'12''N, longitude: 6º46'44''W 1252 m a.s.l.). The total capacity of the reservoir, spreading over 25 ha, is 1680 x 10^3 m^3. Maximum depth is 17 m and mean depth is 6.7 m. Because of the influence of Mediterranean climate precipitation occurs mainly in autumn and winter, but in a very irregular regime. This reservoir was created for urban supply to Bragança city (inhabitants). As a result of the reservoir use, the reservoir hydrological cycle was characterised by the following regime: (1) Maximum level phase, from January to the beginning of June; (2) Emptying phase, from mid June to the beginning of September; (3) Minimum level phase, from mid September to the beginning of the first autumn/winter rain events. The annual range of water level variation is between 8 and 10 m. The highest values of total phosphorus, soluble reactive phosphorus, nitrate, water colour and chlorophyll *a* were found during the minimum level phase. Therefore, reservoir is more eutrophic during the low level phase.

In Bragança the water demand per year is around 2,751,884 m^3. Approximately 80% of this water is for domestic consumption, the remainder for commercial and industrial purposes. Currently, the S. Serrada reservoir can supply urban supply annually, with 95% safety, around 2,100,000 m^3. Thus, the water source of the S. Serrada reservoir is always complemented with other alternative supply water systems. These values indicate that might exist a wasteful water usage scenario. It is of common sense that wasteful water usage can have extremely negative impacts on ecological potential of the water bodies and increase the costs (economic and energetic) of the water supply to populations. Therefore, the aim of the present study is to evaluate the technical and economic feasibility for improve water use efficiency in some public buildings in Bragança. Solutions were proposed for two school centers and municipal swimming pools (e.g. regulation, placement of accessories and replacement of using devices,

such as taps and showers, reuse of gray water, from washbasins, showers, washing of swimming pool filters and the use of rainwater to flush toilet bowls, as well as changing irrigation behaviors due to changes in water intensity or irrigation periods).

Table 1 presents an estimate of the values of water consumed annually in the three studied buildings, based on data provided by the municipality and measured "in situ", as well as an estimate of the annual water savings and the return on investment, associated with the solution considered more viable and that in the case of school centers (Sé and Santa Maria) promotes the use of rainwater.

Table 1: Annual estimate of drinking water consumed, water savings and return on investment time associated with the most viable solution

Public buildings	**Sé school center**	**Santa Maria school center**	**Municipal swimming pools**
Water consumption (m^3/year)	5,016,66	2,604,17	16,560,48
Water saving with water efficiency measures (%)	58,63 (1)	69,13 (2)	20,39 (3)
Initial investment (€)	41,557,79	30,845,62	3,149,48
Savings on water bills (€/year)	7,830,72 (4)	8,036,74 (4)	17,655,92
Return on investment time	6 years	4 years	3 months

(1), (2) Replacement of using devices with more efficient ones, use of rainwater and changing irrigation behaviors;
(3) Replacement of using devices with more efficient ones;
(4) Water savings obtained by changing irrigation behavior were not included.

Despite of preliminary this study indicates that it is possible with relatively low cost and without jeopardizing the human need reduce the water consumption. Indeed, the existence of losses associated with inefficient use prevents a reduction in water consumption, desirable in a climate change scenario, in which the risk of periods of prolonged drought is increasingly becoming a reality. A decrease in the volume of water used would imply a reduction in wastewater and the financial costs associated with its treatment and also energy savings (according to APA (2012) 6 to 18% of the energy consumed in cities is due to the transport and treatment of water). In this particular case, it would also reduce the pressures in S. Serrada, minimizing the amplitudes of fluctuations in the water level. In addition to making it possible to prolong supply in the event of extreme drought, the ecological potential of S. Serrada would also benefit.

Keywords: reservoir, ecological potential, water efficiency and reuse, water saving.

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Final Program

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CONFERENCE PROGRAM

14:30 to 14:45	**Milousi, M., Souliotis, M., Papaefthimiou, S.** *"Approaching Circular Economy in solar thermal technologies via the application of Life Cycle Assessment and Eco-design principles"*
14:45 to 15:00	**Papadaki, D., Nikolaou, D.A., Tisov, A., Ritzen, M., Op't Veld, P., Assimakopoulos, M.N.** *"Circularity in the built environment: a case study in an apartment in Athens"*
15:00 to 15:15	**Saidani, M., Yannou, B., Leroy, Y., Cluzel, F., Kim, H.** *"Multi-tool methodology to evaluate action levers to close-the-loop on critical materials – Application to precious metals used in catalytic converters"*
15:15 to 15:45	**Discussion**
13:30 to 15:45	**Session 9B – parallel session** **Chair: Josep-Maria Arauzo-Carod**
13:30 to 13:45	*Preparation time*
13:45 to 14:00	**Arauzo-Carod, J.M.** *"Location determinants and sustainability: an exploratory approach"*
14:00 to 14:15	**Maraveas, C.** *"Environmental Sustainability of Plastic in Agriculture"*
14:15 to 14:30	**Karytsas, S., Vardopoulos, I., Theodoropoulou, E.** *"Adoption of microgeneration technologies in the residential sector: a comparison between two time periods"*
14:30 to 14:45	**Chaves, R., Raufflet, E.** *"Circular business model: understanding the concept and its applications"*
14:45 to 15:00	**Ghosal, B.B.** *"The Art of Selling the Circle - Popularizing Circularity with New-Age: Communication and Outreach"*
15:00 to 15:15	**Argyrou, M.D., Tsipouri, L.J.** *"Using Public Procurement of Innovation as an appropriate tool for the effective implementation of SSS for enhancing the CE: the case of Greece"*
15:15 to 15:45	**Discussion**
15:45 to 18:15	**Session 10A – parallel session** **Chair: Ioanna Vasiliadou**
15:45 to 16:00	*Preparation time*
16:00 to 16:15	**Diamantis, V.** *"Anaerobic co-digestion of sewage sludge and lipids enables energy neutral municipal wastewater treatment facilities"*
16:15 to 16:30	**Campos, G.H., Mucha, A.P., Almeida, C.M.R., Calheiros, C.S.C.** *"Floating Wetland Islands as engineered green systems"*
16:30 to 16:45	**Vasiliadou, I., Tsagarakis, K.P.** *"Carbon footprint analysis of wastewater treatment plants"*
16:45 to 17:00	**Antão-Geraldes, A.M., Silva, F., Morais, T., Vale, P., Zavattieri, C., Albuquerque, A.** *"From the reservoir to the city: A contribution to promote the sustainable use of water"*