INTED 2024

18th International Technology, Education and Development Conference

4-6 March 2024
Valencia (Spain)

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INTED2024 Proceedings
18th International Technology, Education and Development Conference
March 4th-6th, 2024
Valencia, Spain

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DOI: 10.21125/inted.2024
ISBN: 978-84-09-59215-9
ISSN: 2340-1079

Book cover designed by J.L. Bernat

These proceedings are published by IATED Academy. The registered company address is Plaza Legión Española 11, 46010 Valencia, Spain.

Bibliographic Information

Book Title
18th International Technology, Education and Development Conference

Book Series
INTED Proceedings

Editors
Luis Gómez Chova
Chelo González Martínez
Joanna Lees

Publication Year
2024

Publisher
IATED Academy

Publisher Address
Valencia, Spain

Book ISBN
978-84-09-59215-9

Series ISSN
2340-1079

DOI
10.21125/inted.2024

Conference Name
INTED2024

Dates
March 4th-6th, 2024

Location
Valencia, Spain

Topics
Education
Educational Research
Educational Technology

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PROMOTING WATER EFFICIENCY IN A STUDENT RESIDENCE AS A CONTRIBUTION TO SUSTAINABILITY: HYDROSAAP INNOVATION PROJECT

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Abstract

This study presents the preliminary results of the "HydroSAAP" innovation project, promoted by a Higher Education Institution in the northeast of Portugal, and ongoing since May 2023. It aims to improve the management of water consumption in a student residence, while promoting technical and scientific knowledge about rainwater harvesting systems, still little explored in Portugal. The project phases are: (1) installation of a rainwater harvesting system for non-potable uses, and water-efficient devices (showers and taps); (2) estimation of water consumption per use after installation of the system and devices, and promotion of technical and scientific knowledge about the system and (3) knowledge transfer to the academic community and other stakeholders. The results of this project include the completion of phase 1 in July, with the installation of the system, seven showers and a kitchen tap with a class A water efficiency rating and certified by a national organization. Phases 2 and 3 are underway. In phase 2, the quality of the rainwater collected by the system has been analyzed since September. Preliminary results indicate that water from the first rains, after a long dry period, must be discarded. In phase 3, the project has already been combined with educational practice, having been disseminated to the academic community through the organization of the Seminar "Sustainability in the use of water: Importance, techniques and challenges" which took place at the Institution, with the participation of experts in the field of sustainable water use and reuse, mostly involving students from Civil and Environmental Engineering and local stakeholders. It is important to note that the involvement of the students, the residence users and other stakeholders in this project will help to disseminate the obtained knowledge and could be the starting point for further promoting education for sustainable water use. It is also intended to replicate this project for other types of buildings and other non-potable uses, and to extend it to the industrial and agricultural sectors. As the activities of this project will be extended beyond the funding period, it is hoped that it will make an overall contribution to promoting sustainable water management in urban areas.

Keywords: Water efficiency, rainwater harvesting system, student residence, education for sustainable water use, STEAM.

1 INTRODUCTION

Faced with climate change, extreme precipitation and drought events are expected to increase, affecting water availability [1-4]. In addition to the constraints on water availability caused by climatic factors, many urban areas face demographic and pollution phenomena that can affect the efficient water supply to the population [5]. Therefore, it is crucial to manage water resources in urban areas sustainably and additionally implement measures leading to water efficiency to ensure water supply and avoid degradation of the aquatic ecosystems that supply cities, such as reducing consumption by installing water-efficient devices (e.g., taps, showers, and flushing cisterns), without neglecting behavioural aspects; reducing losses and waste; reusing and recycling water, and using alternative sources for non-potable uses [6-9]. Rainwater harvesting is one of the most promising alternative water sources, as it can be easily collected and used for non-potable purposes with or without significant treatment [10]. Therefore, to improve the management of water consumption in a student residence at the Polytechnic

ISBN: 978-84-09-59215-9

Institute of Bragança, in the northeast of Portugal, while promoting technical and scientific knowledge about rainwater harvesting systems, still little explored in Portugal, was conceived in May 2023, the HydroSAAP innovation project "Promoting water efficiency in buildings: Installation and evaluation of the performance of a rainwater harvesting system and efficient devices", funded by the Recovery and Resilience Plan (PRR: Youth Impulse STEAM Program). It is aligned with the objectives of the Institution's Strategic Plan: Co-Creating a Sustainable Future, implementation 2022-2026, and aims to contribute to affirming the Strategic Alliance for Regional Transition (STARS EU), of which the Institution is a partner. The implementation of this project also has the potential to contribute to a sustainable future, in line with the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda, namely SDG 6 - Clean water and sanitation; SDG 11 - Sustainable cities and communities, and SDG 13 - Climate action (Fig. 1).

Figure 1. Sustainable Development Goals addressed in the project [11].

In this context, and given the growing concern about water scarcity, Higher Education Institutions, as places responsible for educating future leaders, must adopt a strong sustainability policy, namely by implementing water efficiency measures on their *Campus* [12]. The use of more efficient devices and rainwater harvesting are essential to move towards sustainable development, but awareness campaigns and other measures to increase education on water efficiency are also needed [12,13]. A very recent study [14] on promoting education for sustainability involves the younger generations in understanding the importance of water resources, related urban water management, wastewater recycling and environmental education. The study focused on the design and construction of a decentralized wastewater treatment and reuse system for the efficient irrigation of a school garden. The success of the study highlights the importance of integrating wastewater management and the design of educational gardens, which can provide an ecological solution to water resource management. The study can serve as a model for other schools to adopt a participatory approach to environmental education, particularly regarding the importance of sustainable wastewater management. In fact, according to [15], the teaching of water from a sustainable perspective can create awareness and values about nature and the environment in students, knowledge that contributes to the rational use of water and participation in sustainable development.

The HydroSAAP innovation project also aims to contribute to education for sustainable water use, involving the academic community, residence users, and other stakeholders and can be replicated in future research.

2 METHODOLOGY

The male student residence (Fig. 2) is located in the city of Bragança (latitude: 41º48'20'' N; longitude: 6º45'25''; altitude: 673 m), a city in the northeast of Portugal with 24,078 inhabitants [16]. The climate is continental with Mediterranean influences. Annual mean precipitation is around 700 mm per year, occurring mainly in autumn and winter but in a very irregular pattern [17]. The building consists of 5 floors including an attic. The building's roof is made of ceramic tiles, covering an area of 198.17 m^2. It has around 50 users (students and employees) and water consumption was previously estimated according to the study by [18], in the following uses: showers (61%), kitchen tap (20%), urinals (7%), flushing cisterns (5%), washbasin taps (4%), washing machine (2%) and other uses (1%). The phases of the HydroSAAP innovation project are presented in Table 1.

Figure 2. Location of student residence (a); front elevation (b).

Table 1. Phases of the HydroSAAP innovation project.

Phases	***Description***
Phase 1	▪ Installation of a rainwater harvesting system for non-potable uses, such as: o Floor washing and irrigation of green areas ▪ Water-efficient devices o Showers and kitchen tap
Phase 2	▪ Estimation of water consumption per use after installation of the system and devices (by carrying out a survey to the residents and employees, see Appendix A) ▪ Promotion of technical and scientific knowledge about the system (e.g., evaluation of the quality of the collected rainwater considering the type of roof, local climatic conditions, and storage time in the reservoir)
Phase 3	▪ Knowledge transfer to the academic community and other stakeholders o Disseminate the system and devices installed and the knowledge obtained in phase 2 o Raise awareness of the importance of the project in water management o Organize seminars, lectures and school visits to the building, as well as activities in collaboration with civil society institutions such as the Ciência Viva Centre of Bragança

The survey about “Water consumption habits in the student residence” was approved by the Institution's Ethics Committee at the end of November 2023 and will be addressed to the residents and employees (see Appendix A). Water quality parameters will be determined in triplicate according to the analytical methodology described by [7].

3 RESULTS

3.1 Phase 1

Phase 1 of the project, which includes the installation of a rainwater harvesting system for non-potable uses, such as washing floors and watering green areas, and water-efficient devices (showers and taps), was carried out in July 2023, involving:

- Intervention in the residence's rainwater drainage network, including the cutting of 2 downpipes (DP1 and DP2) at ground floor ceiling level, the connection between them and subsequent connection to the reservoir to be installed (Fig. 3-a and 3-b);

- Installation of a rainwater harvesting system, consisting of a 1.5 m^3 capacity reservoir and built-in particle filter (Fig. 3-c);
- Installation of a pumping unit (Fig. 3-d);
- Fixing pipes to an existing wall and fitting two garden taps, as well as the respective signage by [19] (Fig. 3-e and f);
- Installation of seven showers (flow rate between 5 and 7.2 L/min) and a kitchen tap (flow rate of 8 L/min) with a class A water efficiency rating and certified by a national organization (Fig. 3-g and h).

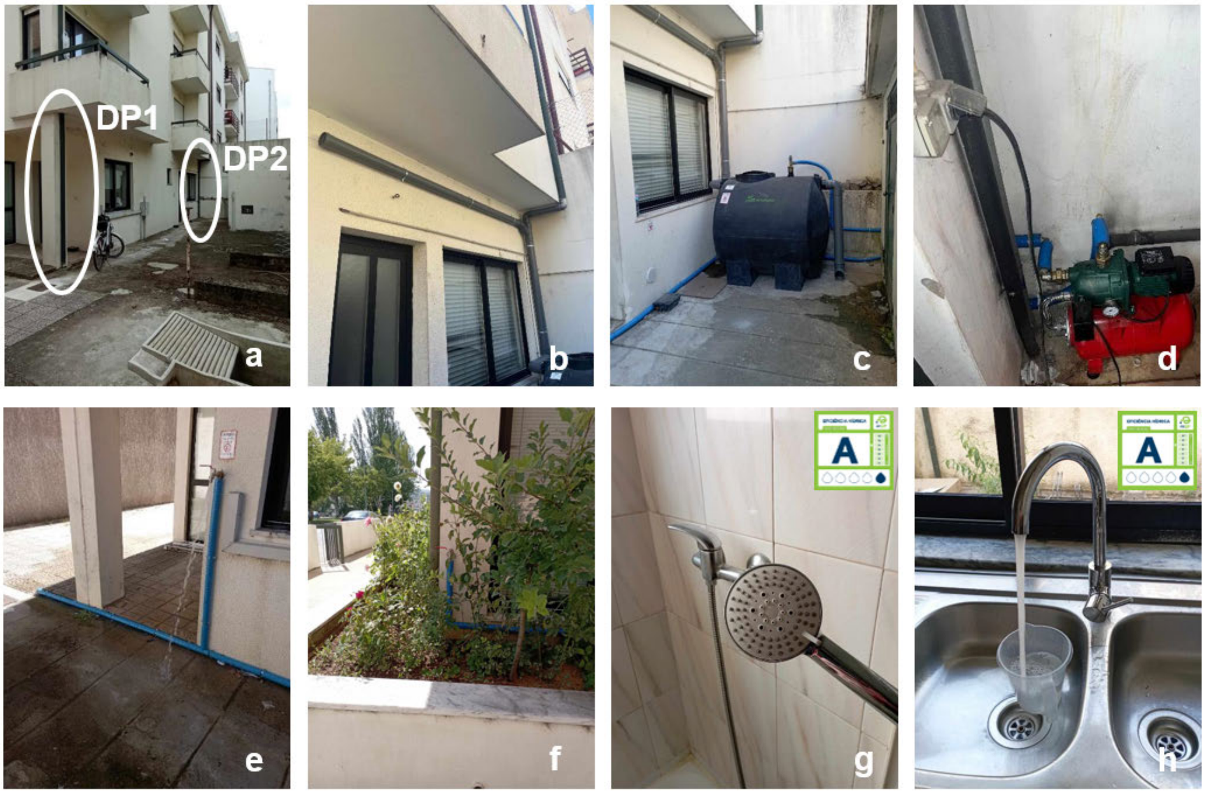

Figure 3. Execution of the work.

3.2 Phase 2

Phase 2 is underway and aims to promote technical and scientific knowledge about the system and the devices installed.

The survey will be addressed between March and June 2024 to users and employees at the residence to estimate water consumption after water-efficient devices have been installed. The quality of the rainwater collected by the system has been analyzed since September 2023 (Fig. 4-a to c). It should be noted that the rainwater is not yet being used for the planned non-potable uses. The rainwater harvesting systems realized according to [19] provide basic treatment by filtration (in the upstream filter) and by sedimentation and flotation (in the reservoir). For watering green areas and floor washing, rainwater may not need any additional treatment, provided that the requirements mentioned in [19] are observed. However, it is recommended that the water at least fulfills the quality standards applicable to bathing water.

Figure 4. Rainwater collection: Reservoir (a); garden tap A (b); garden tap B (c).

The preliminary results of the rainwater analyses are shown in Table 2 for samples 1 and 2 and in Table 3 for samples 3 and 4. The results of some physicochemical parameters are similar to those obtained in the study by [7]. The highest values are observed in the first sample (Table 2), after some time with little or no precipitation (June to August 2023) [20]. Higher values of microbiological parameters are observed in samples 1, 2 and 3 (Tables 2 and 3), dropping significantly in sample 4 (Table 3).

Table 2. Rainwater parameters recorded in September and October 2023.

Parameters	**Sample 1**			**Sample 2**		
	R [1]	***TA*** [2]	***TB*** [3]	***R*** [1]	***TA*** [2]	***TB*** [3]
Temperature (ºC)	21.0	21.0	21.0	19.0	19.0	19.0
pH [4]	7.3	6.8	6.9	6.4	6.3	6.2
Conductivity (µS/cm)	78.5	44.5	45.7	27.7	23.4	24.8
Turbidity (NTU) [4]	4.5	13.7	12.8	2.7	7.5	3.3
Alkalinity (mg $CaCO_3$/L)	38.1	22.6	21.2	30.8	30.1	31.0
Total solids (mg/L)	0.04	0.04	0.05	0.04	0.01	0.01
Total suspended solids (mg/L) [4]	0.002	0.01	0.007	0.002	0.004	0.002
Hardness (mg $CaCO_3$/L)	50.7	27.0	28.0	12.0	12.0	12.0
Nitrite (mg NO_2^-/L)	0.11	<0.01	<0.01	0.09	0.03	0.02
Nitrate (mg NO_3^-/L)	1.67	1.39	1.11	0.6	0.4	0.4
Ammoniacal nitrogen (mg NH_4^+/L) [4]	4.3	2.6	3.0	1.3	1.1	1.2
Phosphate (mg PO_4^{3-}/L)	1.3	0.4	0.5	0.7	0.6	0.6
Sulphate (mg SO_4^{2-}/L)	51.8	24.6	33.9	14.7	18.5	15.0
COD (mg O_2/L)	68.0	22.3	38.1	16.3	2.2	2.2
Heterotrophic plate counts 22 ºC (CFU/mL)	9.5E+06	2.5E+06	3.0E+06	9.9E+05	7.0E+05	4.9E+05
Heterotrophic plate counts 37 ºC (CFU/mL) [5]	6.8E+06	2.5E+06	3.0E+06	7.7E+05	5.4E+05	3.1E+05
Fecal coliforms (CFU/mL) [5]	1.9E+03	1.9E+03	1.6E+03	2.0E+02	8.0E+01	1.1E+02
Total coliforms (CFU/mL)	7.0E+05	5.0E+05	4.0E+05	2.8E+02	2.2E+02	1.4E+02
Fecal streptococci (*Enterococci*) (CFU/mL)	9	6	8	12	10	11

[1] Reservoir; [2] Garden tap A; [3] Garden tap B; [4] Watering green spaces water quality requirements: pH: 6.0-9.0; Turbidity ≤ 5 NTU; TSS ≤ 10 mg/L; Ammoniacal nitrogen ≤ 10 mg/L; Escherichia coli ≤ 10 (CFU/100 mL) [21]; [5] may indicate the presence of pathogen bacteria and other microorganisms [22].

Table 3. Rainwater parameters recorded in November and December 2023.

Parameters	Sample 3			Sample 4		
	R [1]	TA [2]	TB [3]	R [1]	TA [2]	TB [3]
Temperature (ºC)	17.2	17.2	17.2	16.6	16.6	16.6
pH [4]	6.8	6.7	6.7	6.3	6.3	6.4
Conductivity (µS/cm)	33.4	38.0	38.4	29.6	26.4	25.9
Turbidity (NTU) [4]	2.4	1.3	1.2	1.4	1.9	1.5
Alkalinity (mg $CaCO_3$/L)	53.4	44.8	42.2	39.6	37.0	39.6
Total solids (mg/L)	0.03	0.03	0.02	0.08	0.08	0.06
Total suspended solids (mg/L) [4]	0.005	0.007	0.006	0.013	0.012	0.008
Hardness (mg $CaCO_3$/L)	12	13	12	6	6	7
Nitrite (mg NO_2^-/L)	0.11	0.03	0.03	0.06	0.04	0.03
Nitrate (mg NO_3^-/L)	1.2	1.5	1.6	2.1	1.9	1.9
Ammoniacal nitrogen (mg NH_4^+/L) [4]	0.4	0.6	0.6	0.5	0.5	0.5
Phosphate (mg PO_4^{3-}/L)	0.1	0.1	0.1	0.2	0.2	0.2
Sulphate (mg SO_4^{2-}/L)	29.1	29.9	27.6	31.0	27.2	27.9
COD (mg O_2/L)	24.5	13.6	13.6	10.9	16.3	10.9
Heterotrophic plate counts 22 ºC (CFU/mL)	2.9E+05	2.8E+05	3.0E+05	8.3E+04	1.3E+05	1.3E+05
Heterotrophic plate counts 37 ºC (CFU/mL) [5]	5.3E+04	1.5E+05	1.7E+05	1.0E+04	1.6E+04	3.4E+04
Fecal coliforms (CFU/mL) [5]	3.7E+01	2.7E+01	3.3E+01	0	0	0
Total coliforms (CFU/mL)	9.0E+01	4.7E+01	5.7E+01	0	1	0
Fecal streptococci (*Enterococci*) (CFU/mL)	8	3	2	0	0	0

[1] Reservoir; [2] Garden tap A; [3] Garden tap B; [4] Watering green spaces water quality requirements: pH: 6.0-9.0; Turbidity ≤ 5 NTU; TSS ≤ 10 mg/L; Ammoniacal nitrogen ≤ 10 mg/L; Escherichia coli ≤ 10 (CFU/100 mL) [21]; [5] may indicate the presence of pathogen bacteria and other microorganisms [22].

Preliminary results suggest that rainwater may fulfill quality requirements for watering green areas [21]. However, prolonged periods without rain may result in contamination of the roof with a variety of micropollutants, some of which may exceed water quality standards [23]. Roofing material and atmospheric deposition are the sources of contamination [23-25]. In addition, dust [26,27] and rodents, lizards and birds' feces, which can be the main sources of pathogens [25], can accumulate on roofs during dry periods and affect the quality of the water collected. In areas of low industrial activity, such as the Bragança region, the phosphate observed is of natural origin (bird and rodent feces, mosses, lichens and plant remains). Nitrate and nitrite, on the other hand, maybe products of road traffic [25]. Therefore, these preliminary results indicate that it is necessary to discharge at least the first rainwater after a long dry period (first flush), as recommended by [19]. Rainwater may need to be properly treated before it can be used for non-potable purposes, such as watering green areas or floor washing. Therefore, given the knowledge acquired so far, further physicochemical and microbiological analyzes will be necessary to monitor the quality of the water collected by the system according to variables such as local climatic conditions and storage.

3.3 Phase 3

In phase 3, the project has already been combined with educational practice, having been disseminated to the academic community through the organization of the seminar "Sustainability in the use of water: Importance, techniques and challenges", which took place in November 2023 at the Institution, with the participation of experts in the field of sustainable water use and reuse, mostly involving students from Civil and Environmental Engineering and local stakeholders (Fig. 5-a and b).

Figure 5. Poster promoting the seminar (a); presentation of the HydroSAAP innovation project during the seminar (b).

To promote education for sustainable water use, the activities of this phase have been disseminated on the institution's internal communication channels and social networks, as well as on external communication channels (Fig. 6-a and b).

Figure 6. Dissemination of the project in the local newspaper (a) [28]; Wise Connect podcast episode (b) [29].

As part of this project, a master's thesis in Environmental Technology is in progress. It aims to evaluate the potential for water efficiency and the water-energy nexus in the student residence, considering the water and energy consumption associated with hot water production in the building and the reductions made possible by the solutions integrated into the HydroSAAP innovation project and others to be considered.

It is intended to continue: (i) disseminate the system and the devices installed, and the knowledge obtained in phase 2; (ii) raise awareness of the importance of the project in water management and organize lectures, for example on World Water Day, and school visits to the building, and (iii) promote activities in collaboration with civil society organizations, such as the Ciência Viva Centre of Bragança, to educate for the sustainable use of water.

4 CONCLUSIONS

It is critical to manage water resources sustainably and, in addition, to implement measures that lead to water efficiency to ensure public supply and prevent the degradation of the aquatic ecosystems that supply cities. This project could be the starting point for promoting the reduction of potable water consumption in students' residences, and for adapting to and minimizing the effects of the climate change we are experiencing, helping to promote the sustainability of the urban environment and a participatory approach to education for sustainable water use.

ACKNOWLEDGEMENTS

The authors are grateful to the Foundation for Science and Technology (FCT, Portugal) for financial support by national funds FCT/MCTES (PIDDAC) to CIMO (UIDB/00690/2020 and UIDP/00690/2020), SusTEC (LA/P/0007/2020), FibEnTech (UIDB/00195/2020) and GeoBioTec (UIDB/04035/2020).

REFERENCES

[1] O. Edenhofer, Climate Change 2014: Mitigation of Climate Change: Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. In Summary for Policymakers; Edenhofer, O.R., Pichs-Madruga, Y., Sokona, E., Farahani, S., Kadner, K., Seyboth, A., Adler, I., Baum, S., Brunner, P., Eickemeier, B., et al., Eds.; Cambridge University Press: New York, NY, USA, 2014.

[2] IPCC. Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change; Pörtner, H.-O., Roberts, D.C., Tignor, M., Poloczanska, E.S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., et al., Eds.; Cambridge University Press: New York, NY, USA, 2022.

[3] C. Carvalho-Santos, A.T. Monteiro, J.C. Azevedo et al. Climate Change Impacts on Water Resources and Reservoir Management: Uncertainty and Adaptation for a Mountain Catchment in Northeast Portugal. *Water Resour Manage*, vol. 31, 3355-3370, 2017. https://doi.org/10.1007/s11269-017-1672-z

[4] Soares P.M.M., Cardoso R.M., Ferreira J.J. et al. Climate change and the Portuguese precipitation: ENSEMBLES regional climate models results. *Clim Dyn*, vol. 45, 1771-1787, 2015. https://doi.org/10.1007/s00382-014-2432-x

[5] King S., Kenway S. K., Renouf M. A. How has urban water metabolism been communicated? Perspectives from the USA, Europe and Australia. *Water Sci Technol*, vol. 79, no. 9, 1627-1638. 2019. https://doi.org/10.2166/wst.2019.139

[6] F. Silva, C.S.C. Calheiros, G. Valle, P. Pinto, A. Albuquerque, A.M. Antão-Geraldes. Influence of Green Roofs on the Design of a Public Stormwater Drainage System: A Case Study. *Sustainability*, vol. 15, no. 7: 5762, 2023. https://doi.org/10.3390/su15075762

[7] A.M. Antão-Geraldes, M. Pinto, M.J. Afonso, A. Albuquerque, C.S.C. Calheiros, F. Silva. Promoting Water Efficiency in a Municipal Market Building: A Case Study. *Hydrology*, vol. 10, no. 3: 69, 2023. https://doi.org/10.3390/hydrology10030069

[8] E.A Kilinc, A. Tanik, A. Hanedar, E. Gorgun. Climate Change Adaptation Exertions on the Use of Alternative Water Resources in Antalya Türkiye. *Front. Environ. Sci*. 2023. https://doi.org/10.3389/fenvs.2022.1080092

[9] F. Silva, A.M. Antão-Geraldes, C. Zavattieri, M.J. Afonso, F. Freire, A. Albuquerque, A. Improving Water Efficiency in a Municipal Indoor Swimming-Pool Complex: A Case Study. *Applied Sciences*, vol. 11, no. 22: 10530, 2021. https://doi.org/10.3390/app112210530

[10] C. Matos Silva, V. Sousa, N.V. Carvalho. Evaluation of rainwater harvesting in Portugal: Application to single-family residences. *Resources, Conservation and Recycling*, vol. 94, 21-34, 2015. https:// doi.org/10.1016/j.resconrec.2014.11.004

[11] UNESCO. Available online: https://en.unesco.org/sustainabledevelopmentgoals (accessed on 5 January 2024).

[12] A.M. Barreiros, A. Durão, A. Galvão, A.; Matos, C.; Mateus, D.; Araújo, I.; Neves, L.; Matos, M.; Mourato, S. Analyzing Green Behavior and the Rational Use of Water in Portuguese Higher Education Campi. *Sustainability*, vol. 15, no. 4: 3035, 2023. https://doi.org/10.3390/su15043035

[13] F. Ruiz-Garzón, M.d.C. Olmos-Gómez, L.I. Estrada-Vidal. Perceptions of Teachers in Training on Water Issues and Their Relationship to the SDGs. *Sustainability*, vol. 13, no. 9: 5043. 2021. https://doi.org/10.3390/su13095043

[14] H. Nourredine, M. Barjenbruch, A. Million, B. El Amrani, N. Chakri, F. Amraoui. Linking Urban Water Management, Wastewater Recycling, and Environmental Education: A Case Study on Engaging Youth in Sustainable Water Resource Management in a Public School in Casablanca City, Morocco. *Education Sciences*, vol. 13, no. 8: 824, 2023. https://doi.org/10.3390/educsci13080824

[15] G. Martínez-Borreguero, J. Maestre-Jiménez, M. Mateos-Núñez, F.L. Naranjo-Correa. Water from the Perspective of Education for Sustainable Development: An Exploratory Study in the Spanish Secondary Education Curriculum. *Water*, vol. 12, no. 7: 1877, 2020. https://doi.org/10.3390/w12071877

[16] Censos 2021. Available online: https://censos.ine.pt/xportal/xmain?xpgid=censos21_main&xpid=CENSOS21&xlang=pt (accessed on 05 January 2024).

[17] IPMA - Séries Longas. Available online: https://www.ipma.pt/pt/oclima/series.longas/?loc=Bragan%C3%A7a&type=raw (accessed on 5 January 2024).

[18] H. Faria. *Uso eficiente de água na residência Gulbenkian do Instituto Politécnico de Bragança*. Master Dissertation. Instituto Politécnico de Bragança. 2020.

[19] Technical Committee 0701. Available online: https://anqip.pt/index.php/en/technical-committees/93-comissao-tecnica-0701 (accessed on 05 January 2024).

[20] Instituto Português Do Mar E Da Atmosfera. Available online: https://www.ipma.pt/pt/publicacoes/boletins.jsp?cmbDep=cli&cmbTema=pcl&idDep=cli&idTema=pcl&curAno=-1 (accessed on 05 January 2024).

[21] Água Para Reutilização (ApR) | Agência Portuguesa Do Ambiente. Available online: https://apambiente.pt/agua/agua-para-reutilizacao-apr (accessed on 05 January 2024).

[22] Heterotrophic Plate Counts and Drinking-Water Safety: The Significance of HPCs for Water Quality and the Human Health. Available online: https://www.who.int/publications-detail-redirect/9241562269 (accessed on 05 January 2024).

[23] P.-J, De Buyck, S.W.H. Van Hulle, A. Dumoulin, D.P.L. Rousseau. Roof Runoff Contamination: A Review on Pollutant Nature, Material Leaching and Deposition. *Rev. Environ. Sci. Biotechnol.* vol. 20, 549-606, 2021. https://doi.org/10.1007/s11157-021-09567-z

[24] D.J. Lye. Rooftop Runoff as a Source of Contamination: A Review. *Sci. Total Environ.* vol. 407, Issue 21, 5429-5434. 2009. https://doi.org/10.1016/j.scitotenv.2009.07.011

[25] G.D. Gikas, V.A. Tsihrintzis. Assessment of Water Quality of First-Flush Roof Runoff and Harvested Rainwater. *J. Hydrol.* vol. 466–467, 115–126. 2012. https://doi.org/10.1016/j.jhydrol.2012.08.020

[26] M. Escudero, A. Stein, R.R. Draxler, X. Querol, A. Alastuey, S. Castillo, A. Avila. Determination of the Contribution of Northern Africa Dust Source Areas to PM10 Concentrations over the Central Iberian Peninsula Using the Hybrid Single-Particle Lagrangian Integrated Trajectory Model (HYSPLIT) Model. *J. Geophys. Res. Atmos.*, vol. 111, Issue D6. 2006. https://doi.org/10.1029/2005JD006395

[27] R.M. Rodríguez-Arias, J. Rojo, F. Fernández-González, R. Pérez-Badia. Desert Dust Intrusions and Their Incidence on Airborne Biological Content. Review and Case Study in the Iberian Peninsula. *Environ. Pollut.* vol. 316, 120464. 2023. https://doi.org/10.1016/j.envpol.2022.120464

[28] Jornal Nordeste. Available online: https://www.jornalnordeste.com (accessed on 05 January 2024).

[29] WISE CONNECT. Available online:

[30] https://open.spotify.com/episode/0HvEzm5ZmTzWPLPHxUoHwh (accessed on 05 January 2024).

APPENDIX A

Survey

Questions for residence users:

1. Age:

2. Course attended:

3. Do you play sports in your free time? ☐ Yes ☐ No

    3.1. If you answered “Yes”, indicate which:

        3.1.1. How many times a week do you play sports?

4. How many days a week do you stay at the residence?

5. Indicate an estimate of the number of times you wash your hands while staying at the residence:

    5.1. When you wash your hands, give an estimate of the:

        5.1.1. Number of times you press the touch “button” (if timed touches):

        5.1.2. Time that the tap remains open (in minutes/seconds, in the case of single-lever taps):

6. Indicate an estimate of the number of times you use the toilet as a building user:

    6.1. Each time you use the toilet, give an estimate of the number of flushes you do:

    6.2. Typically, to flush the toilet, you use:

    ☐ The larger “button” (6L) ☐ The smaller “button” (3L) ☐ Both “buttons” at the same time ☐ The single “button” (if there is only one “button”)

7. Give an estimate of the number of times you shower at the residence per week:

    7.1. Give an estimate, in minutes, of the time it takes to shower:

8. During your stay at the residence, do you usually shave?

    ☐ Yes ☐ No

    8.1. If you answered “Yes”, do you use “Gillette” or a shaver?

    8.2. If you use “Gillette”:

        8.2.1. Do you shave while keeping the tap water running?

        8.2.2. Give an estimate of the time, in minutes, it takes to shave?

        8.2.3. How many times do you shave per week?

9. Do you usually use the kitchen tap? ☐ Yes ☐ No

    9.1. If you answered “Yes”, please provide an estimate of the time, in minutes, that you use that tap each day:

10. Do you usually use the washing machine? ☐ Yes ☐ No

    10.1. If you answered “Yes”, please provide an estimate of the number of times you use the washing machine each week and which washing programs you use:

Questions only for residence employees:

11. Indicate how frequently the building floor is washed:

    11.1. Provide an estimate of the amount of water you use per wash:

12. Indicate how frequently green areas are watered:

    12.1. Indicate an estimate of the amount of water you use to irrigate green areas:

13. Have you ever detected any loss or leak in the water networks at the residence?

    ☐ Yes ☐ No

    13.1. If “Yes”, describe what happened: