Water Efficiency Conference 2018

5 – 7 September 2018

University of Aveiro, Portugal

TECHNICAL SOLUTIONS FOR WATER REUSE IN A SOCIAL AND CULTURAL CENTER

Sofia Abrantes, Flora Silva and António Albuquerque

UNIVERSIDADE BEIRA INTERIOR

ipb INSTITUTO POLITÉCNICO DE BRAGANÇA

INTRODUCTION

Water is the most valuable natural resource on the planet.

Its conservation is one of the most important pillars of sustainable development.

In regions where the water scarcity is a natural reality, and where population growth and/or climate change are a source of scarcity, sustainable management of water resources implies conservation of these resources, which should include water reuse procedures.

INTRODUCTION

The Portuguese National Program for the Efficient Use of Water (PNUEA) (2012-2020) for the urban sector intends to:

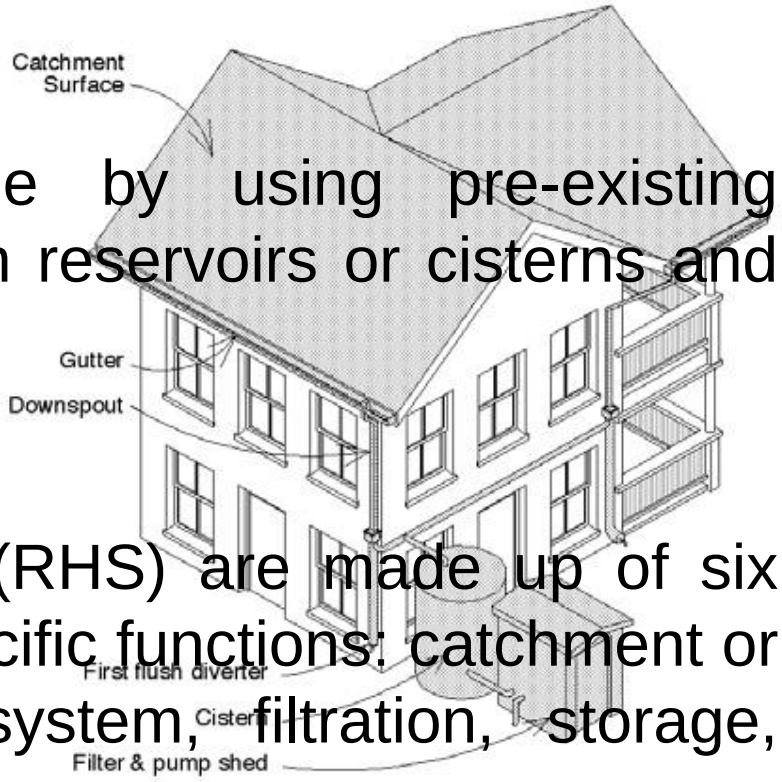
- minimize the use of drinking water in activities that may have the same performance with alternative water quality such as the use of rainwater and the reuse of treated wastewater.

- promote the use of standardized and certified equipment's for the water efficient use, encouraging their production and marketing.

INTRODUCTION

In isolated or decentralized zones, the use of rainwater presents great possibilities of use, once these waters are captured in the place where they will be consumed.

Rainwater harvesting is done by using pre-existing structures, and can be stored in reservoirs or cisterns and used with little or no treatment.



Typical rainwater harvesting installation

Rainwater harvesting systems (RHS) are made up of six basic components with very specific functions: catchment or collection surface, transport system, filtration, storage, distribution and treatment.

INTRODUCTION

In Portugal, the installation and certification of a RHS, although is not to much applied, must comply with the established conditions in two technical specifications developed by the National Association for Quality in Buildings Installations (ANQIP):

- ETA 0701 - establishes the technical criteria for the performance of a RHS in buildings, for purposes other than human consumption;
- ETA 0702 - establishes the conditions for Certification of a RHS.

INTRODUCTION

Due to the high billing of the drinking water consumption in the Social and Cultural Center of Santo Aleixo (SCCSA) (Unhais da Serra, Covilhã, Portugal)

The objective of this study was to:

find possible solutions for reducing the water consumption in the residential building.

Technical and economic feasibility of four solutions and a comparison of these solutions in other areas of the country were also analysed.

METHODOLOGY

Building description and solutions for the reduction of drinking water consumption

The SCCSA is a Private Institution of Social Solidarity, consisting of a residential building with two floors and a building of new valences, having in the surrounding area a garden with about 600 m^2.

It has 27 residents, 27 workers and 4 children in pre-school regime.

Social and Cultural Center of Santo Aleixo: (**a**) residential building; (**b**) building of new valences.

In the 24 sanitary facilities there are 24 flushing cisterns (10L reservoir), 2 of which have dual flushing mechanism and 32 conventional single-lever mixer taps (9 L min^{-1}).

Building description and solutions for the reduction of drinking water consumption

Two options were studied for the reduction of drinking water consumption in the building.

Proposed solutions for the reduction of drinking water consumption.

Currently installed equipment	Proposal of changes		
	Option 1: Replacement and modification of some equipment's		
22 single flushing cisterns 32 conventional taps	Dual flushing cisterns with 6 L/3 L capacity Replacement of 19 conventional taps by temporized taps (ground floor) Installation of flow reducers in 13 taps (1st floor)		
	Option 2: Rainwater harvesting		
	Solution 2-a	**Solution 2-b**	**Solution 2-c**
	Supplying of the flushing cisterns with rainwater	Supplying of the flushing cisterns with rainwater, replacing simple discharge flushing cisterns by dual flushing cisterns with 6 L/3 L capacity	Supplying of the flushing cisterns with rainwater, replacing simple discharge flushing cisterns by dual flushing cisterns with 6 L/3 L capacity and replacement / modification of taps

Building description and solutions for the reduction of drinking water consumption

For option 2, the recalculation of the building networks was done according to the Regulatory Decree no. 23/95, of August 23 and Pedroso.

The supply with rainwater will come from a buried reservoir in a green area in front of the building, from where the water will be pumped into the water supply network.

In the calculation of the reservoir volume for rainwater supply, only the water costs related to the flushing cisterns were considered.

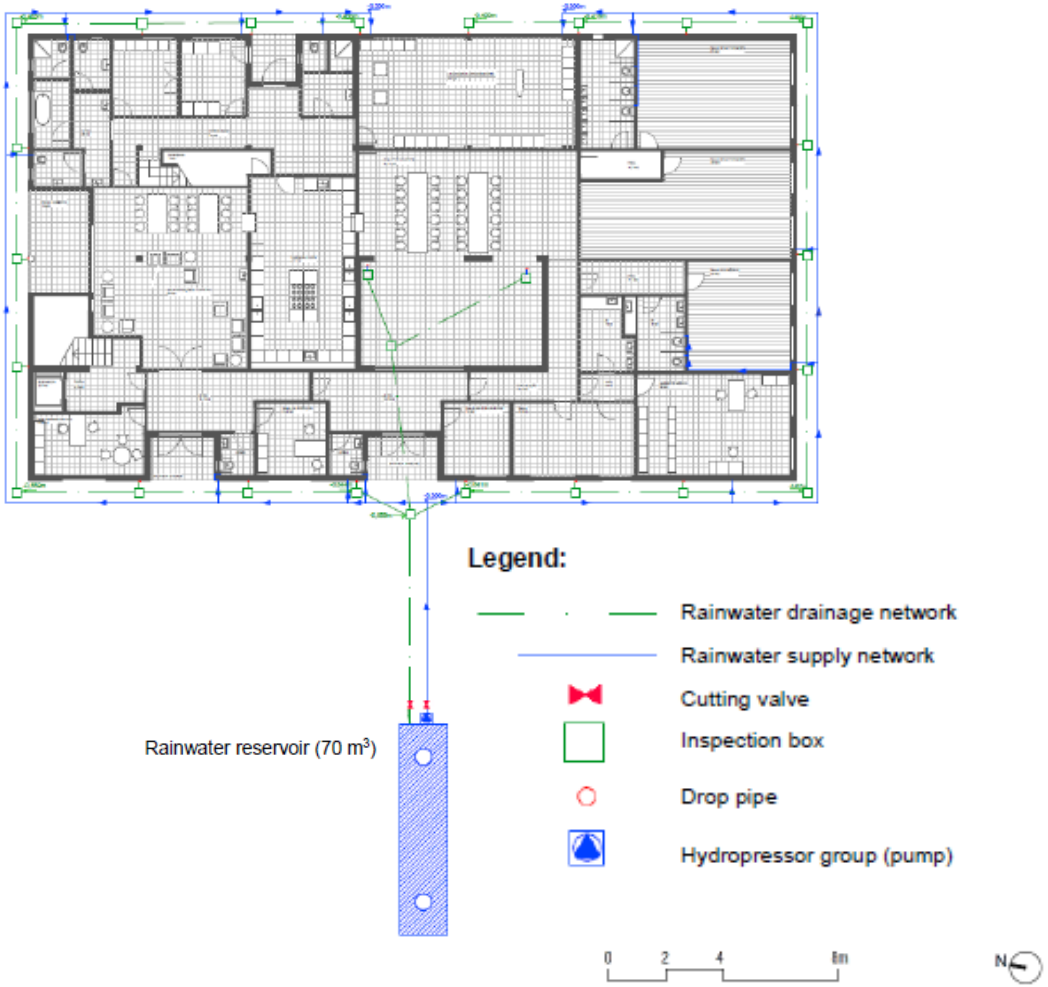
Those costs were calculated taking into account the number of uses per inhabitant/day during 30 days.

In total, it was considered a universe of 40 inhabitants.

A reservoir with 70 m^3 (option 2: solution 2-a) and 30 m^3 (option 2: solutions 2-b and 2-c) would be suitable for the needs of the inhabitants.

METHODOLOGY

Building description and solutions for the reduction of drinking water consumption



Rainwater drainage building network and rainwater supply building network (1st floor).

RESULTS AND DISCUSSION

Technical and economic feasibiliy of the solutions

The two options can be implemented, from the constructive and sanitary hydraulic functioning point of view.

In the rainwater drainage building network, the values of the flow velocities are within the stipulated limits, and the shear stress values could allow good self-cleaning conditions.

In the rainwater supply building network, the flow velocities are within the suggested range (0.5 and 2.0 m s^{-1}) and the hydropressor group will guarantee the minimal pressures needed for the proper functioning of the equipment's.

RESULTS AND DISCUSSION

Technical and economic feasibiliy of the solutions

The economic feasibility study was made based on:

- the volumes of water saved
- the costs of investment, operation, maintenance and inspection
- energy costs
- returning time of the investment.

The most favourable solution was considered the one that presented the greater water savings, associated with a lower investment, lower maintenance and a quick return of the financial investment.

RESULTS AND DISCUSSION

Technical and economic feasibiliy of the solutions

Reduction of the consumed potable water volumes

Average annual volumes of potable water consumed and potential savings.

Average annual volumes of potable water consumed (m^3)					
	Current consumption	Option 1	Option 2		
			Solution 2-a	Solution 2-b	Solution 2-c
Flushing cisterns	792	285.12	228.7	39.9	39.9
Taps	285.12	174.24	285.12	285.12	174.24
Total	1077.12	459.36	513.8	325.0	214.1
Savings (%)	0	57.4	52.3	69.8	**80.1**

The solution 2-a is the one with the higher water consumption, achieving savings of 52.3%.

The solution 2-c would lead to greater saving of potable water (80.1%).

RESULTS AND DISCUSSION

Technical and economic feasibiliy of the solutions

Investment costs

Costs associated with the installed equipment and the modification of the building networks.

	Option 1	Option 2		
		Solution 2-a [1)]	Solution 2-b [2)]	Solution 2-c [2)]
Replacement and modification of sanitary equipment	5 520,00€	0,00€	3 797,04€	5 520,00€
Rainwater drainage network (including equipment, elements and accessories)	0,00€	7 720,36€	7 720,36€	7 720,36€
Rainwater supply network	0,00€	2 085,12€	2 085,12€	2 085,12€
Equipment and its installation (e.g. reservoir, hydropressor group and accessories)	0,00€	21 169,60€	10 569,60€	10 569,60€
Totals	5 520,00€	30 975,08€	24 172,12€	25 895,08€

[1)] *Considering a reservoir with 70 m³.*
[2)] *Considering a reservoir with 30 m³.*

RESULTS AND DISCUSSION

Technical and economic feasibiliy of the solutions

Costs and operating requirements

Costs associated with the replacement of elements and equipment maintenance every 10 years.

	Option 1	Option 2		
		Solution 2-a	Solution 2-b	Solution 2-c
Equipment maintenance and replacement of elements	0,00€	2 256,00€	2 256,00€	2 256,00€

RESULTS AND DISCUSSION

Technical and economic feasibiliy of the solutions

Reduction of the monthly and annual water billing

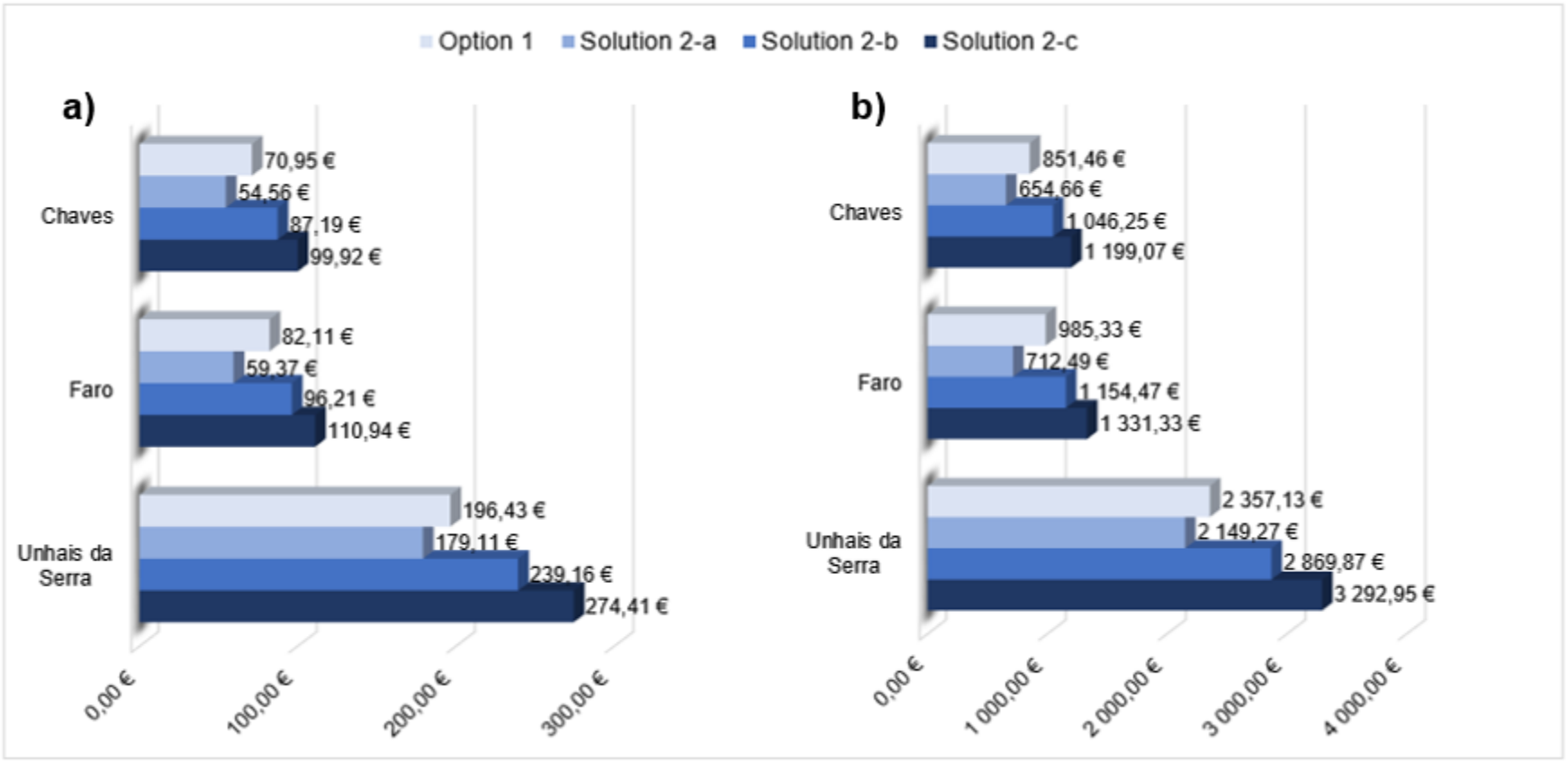
Applying the current tariffs at the municipality of Covilhã, Chaves and Faro, and considering the saved volume of water and the average rainfall relative to each month, from January 2001 to August 2017, the average monthly and annual savings were determined, in relation to the billing of water, sanitation and municipal solid waste services for the two options.

The municipality of Covilhã is the one which has the highest water billing.

RESULTS AND DISCUSSION

Technical and economic feasibiliy of the solutions

Reduction of the monthly and annual water billing



(**a**) Monthly water savings and (**b**) annual water savings, for Unhais da Serra (Covilhã), Faro and Chaves.

RESULTS AND DISCUSSION

Technical and economic feasibiliy of the solutions

Return of the investments

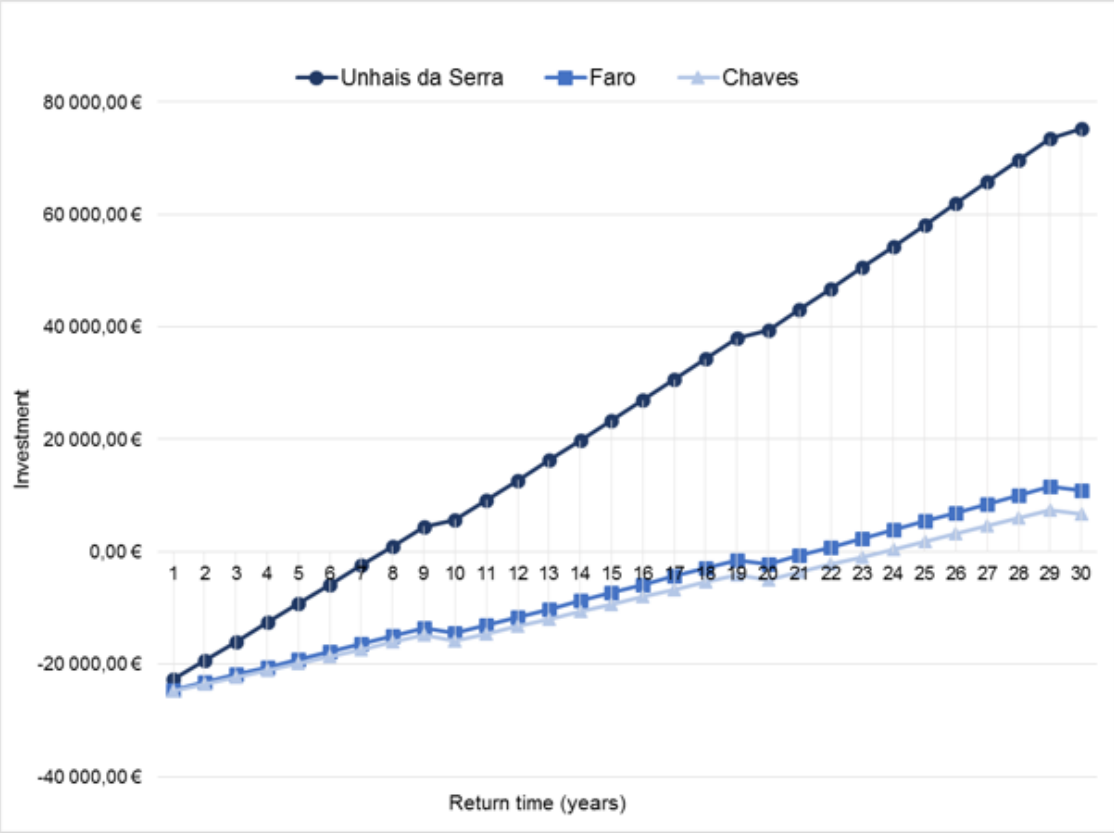
Calculation of the return of the investments for Unhais da Serra (Covilhã), Faro and Chaves (option 2: solution 2-c).

	Option 2: Solution 2-c					
	Unhais da Serra					
Years	1	2	3	...	7	8
Investment value	25 895,08€	0,00€	0,00€	...	0,00€	0,00€
Annual return amount	3 292,95€	3 312,70€	3 332,58€	...	3 413,28€	3 433,76€
Balance	-22 602,13€	-19 289,43€	-15 956,85€	...	-2 425,38€	1 008,38€
	Faro					
Years	1	2	3	...	21	22
Investment value	25 895,08€	0,00€	0,00€	...	2 256,00€	0,00€
Annual return amount	1 331,33€	1 339,32€	1 347,35€	...	1 500,53€	1 509,53€
Balance	-24 563,75€	-23 224,43€	-21 877,08€	...	-706,21€	803,33€
	Chaves					
Years	1	2	3	...	23	24
Investment value	25 895,08€	0,00€	0,00€	...	0,00€	0,00€
Annual return amount	1 199,07€	1 206,27€	1 213,51€	...	1 367,73€	1 375,94€
Balance	-24 696,01€	-23 489,74€	-22 276,23€	...	-929,37€	446,58€

RESULTS AND DISCUSSION

Technical and economic feasibiliy of the solutions

Return of the investments



Returning time for the investment for Unhais da Serra (Covilhã), Faro and Chaves (option 2: solution 2-c).

CONCLUSIONS

The implementation of technical solutions for water efficiency in a social and cultural center can lead to water savings of 57.4%, only changing equipment's and accessories (option 1).

If there is no storage structure, it is necessary to acquire a reservoir for rainwater storage, which involves a high initial investment (option 2).

Rainwater harvesting is not feasible if it is not combined with the introduction of highly water efficient equipment, except when the costs associated with water billing are quite high.

CONCLUSIONS

Replacing the existing sanitary equipment, in order to make them more efficient (option 2: solution 2-c), it can lead to water reductions around 80.1%, with the investment being recovered in 8 years. For a period of 30 years the savings can reach around 75 000,00€.

In areas where water billing reaches high values, it is economically feasible to invest in a RHS, preferably associated to the use of hydraulically efficient equipment's.

In cases where the water billing prices are lower, the most viable investment could be the adoption of high water efficiency equipment.

Water Efficiency Conference 2018

5 – 7 September 2018

University of Aveiro, Portugal

Thank you for your attention!

For additional information please contact:
Sofia Abrantes
sofia.alexandra.abrantes@hotmail.com

UNIVERSIDADE BEIRA INTERIOR

ipb INSTITUTO POLITÉCNICO DE BRAGANÇA