Possibilities of greywater reuse in non-potable *in situ* urban applications, according with its quality and quantity

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Abstract:-Water resources are being, over decades, intensively over explored and polluted, and it is estimated that in a few years, it is reached highly values of water stress in Europe. Portugal is already in the ranking of countries with medium water stress (10-20%). To avoid the deterioration of this situation it is imperative to consider different approaches of water management, such as water reuse strategies.
Toilet flushing, pavements and car washing and garden irrigation are uses in which the quantity of greywater dispended is high and the needs in terms of quality can be lower than the potable water, and so these can represent potential reuse applications in a unfamiliar dwelling. Greywater *in situ* reuse can be a practice to consider since its quality and quantity is enough to consider the uses referred above.
In this context, a research of the quantity and quality of greywater produced in a dwelling, allows to reuse only the water with the best characteristics and so it will require a lower level of treatment.
In this paper is presented the quantitative and qualitative characterization of greywater, as well as the required quantity for its reuse in some *in situ* non-potable urban applications.

Keywords: Greywater, characterization, *in situ,* non-potable, reuse.

1. Introduction

The amount of water needed for domestic consumption in developed countries is around 100-180 l / hab.dia, representing 30-70% of the amount of water required in an urban area [1]. The increased demand for water leads to demand for new more distant sources and / or greater depths, which leads to increased environmental costs and economic exploitation. Therefore, we should consider other solutions such as the development of measures aimed at increasing the efficiency of water use and to promote reuse as an alternative.
The water becomes, inside houses, in two types of wastewater, black water and greywater, which is centralized in a single collector mixture towards a system of single treatment. Greywater is defined as the domestic wastewater without the contribution of black water from the toilets, ie, corresponds to the wastewater from baths, washbasins, bidets, washing machines and dishwashers and kitchen sink [2].
A survey conducted in Germany by the Ministry of Environment showed that 76% of international experts considered technically feasible to use reclaimed water from sinks, bathtubs and showers at the end

less demanding uses, with the same risk to public health offered by the potable water [3]. Even today in some countries like Portugal is used unnecessarily, potable water in cisterns[4][5], which represents 10-45% of the water spends in a dwelling ([1]; [6]; [7]).

It is estimated that the total amount of greywater corresponds to 50-80% of the wastewater drained from a house ([8][1]; [9]; [4]), constituting the largest potential source of water saving, if consider the possibility of reuse. Greywater is therefore an important component of wastewater and, qualitatively, studies have shown that there is a significant contribution of this greywater to the concentration of some pollutants and contaminants in the total wastewater ([10]). In fact, despite being regarded by many as a relatively clean water, greywater can be quite polluted, and its indiscriminate use may represent a risk to public health.

The reuse of greywater *in situ*, may prove to be a practice to consider since its quantity and quality is sufficient to meet the demand for some urban non-potable purposes, such as toilet-flushing, cars-washing and irrigation, since the amount of water required is high and the quality may be lower than the drinking-water.

This paper presents a quantitative characterization, and a physico-chemical and microbiological analysis of total greywater (TGW), light greywater (LGW) and of greywater per domestic device (GDD).

TGW include the water from all sanitary appliances except the toilet. LGW exclude from the previous group the water from the washing machine, dishwasher and kitchen sink.

With this characterization, it is possible to establish the best strategy for reuse, using only the greywater with better quality, ie, excluding the water with more pollutants / contaminants. Moreover, it will allow to know the degree of treatment to consider in each case.

2. Methodology

2.1 Qualitative characterization

2.1.1 TGW and LGW characterization

In order to characterize total greywater (TGW) produced in households, it was changed the drainage system of a dwelling located in *Quinta da Casa Nova* in Sabrosa, Vila Real District, in Tras-os-Montes and Alto Douro region in northern Portugal, in order to collect the greywater that came from a bathroom, comprising bath, toilet and bidet, the greywater that came from the kitchen constituted by the kitchen sink and dishwasher and the greywater from the laundry draining the water generated by the washing machine. The daily occupancy of housing was 4 to 6 people. These wastewaters were sent to a tank in stainless steel AISI 316L, 318 L capacity.

The tank capacity was provided in order to collect all the greywater generated during a day, ensuring thus the homogenization of water from various appliances.

In order to characterize light greywater produced in the dwelling it was disconnected from the system described above the drainage of water from the kitchen and laundry. Thus, were drained into the tank previously described only the greywater from the tub, sink and bidet.

There have been two sampling campaigns to characterize the TGW and one for the characterization of the LGW.

The parameters analyzed (Table 1 and Table 2) were chosen based on the existing law for irrigation water quality([11],[12]). Given the huge analysis costs, the second campaign was less inclusive, repeating only the most relevant parameters.

In each campaign, it was collected a 5.5 L of greywater sample which was well preserved and sent to a laboratory for the analysis of these parameters. In addition to the above parameters were measured some parameters *in situ* with sensors, such as pH, redox, dissolved oxygen and also the electrical conductivity. This last parameter was only measured for the LGW. The reading of electrical conductivity (Ce) can be converted in total dissolved solids (SDT) using the following expression:

$$Ce(dS/m)\times 640 = SDT(mg/l) \quad (1)$$

The knowledge of the electrical conductivity and SDT allows the evaluation of the water salinity, an important parameter for irrigation reuse.

Knowing sodium, calcium and magnesium content (Na+, Ca2+, Mg2+) it was possible to calculate the sodium absorption reason (RAS):

$$RAS = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}} \quad (2)$$

It was made the potable water physic-chemical characterization.

2.1.2 GDD characterization

In order to characterize greywater quality per domestic device, independent samples were taken from eight distinct houses collected and treated at the same day. The houses were unifamiliar, varying in the number of inhabitants from 2 to 6 per house. Greywater was separated by its origin and were collected water samples in both rooms that generated effluents: kitchen and bathroom. In each room, waters were collected concerning its origin: (i) in kitchen we took samples in sink, dishwasher and washing machine, and (ii) in the bathroom samples were taken in wash basin, bath and bidet. This last appliance is widespread in Mediterranean Region.

In each sample the following physic-chemical parameters were analyzed: pH, electric conductivity, TDS, temperature and COD. All of them, except COD, were analyzed with sensors. In respect to microbiological parameters it was determined the total and fecal coliform content in the laboratory.

2.2 Quantitative Characterization of greywater produced by Domestic device

To determine the amount of greywater produced by each domestic device it was performed two sampling campaigns, (7 + 21 days) in 3 different houses, located in Vila Real, Trás-os-Montes and Alto Douro in northern Portugal. During the two campaigns it was observed the volume consumed by each usage, on the counter.

2.3 Characterization of water demand for some urban non-potable aplicattions

To make the quantitative characterization of water demand it was estimated the amount spent for toilet-flushing, car-washing and irrigation. To estimate the amount spent on toilet flushing there were considered the values found in this study and the average household in Portugal of 3.1 inhabitants per dwelling [13]. To estimate the amount of water spent on car-washing and irrigation it was conducted a door to door survey in 12 houses with gardens in a residential area of Vila Real, which recorded the number of times per month or per day that there was car-washing and irrigation, respectively, and the duration of each activity. The consumption data was calculated using the weighted average water consumption of each resident.

3. Results

3.1. TGW and LGW characterization

The values of the parameters analyzed in the TGW, LGW and drinking water are presented in Table 1 and Table 2. In these tables are presented the national legal / regulatory criteria related to water quality for irrigation and the quality requirements for urban reuse of water proposed by EPA [14] (car-washing, toilet-flushing and floor-washing). Additionally, it presents a range of values, or the average value, depending on the cases, taken from the bibliography. Some of the bibliographic values are presented for greywater from various sources (eg kitchen or bathroom) and not necessarily to the mixture of all the greywater.

The most remarkable mark of these waters is the great qualitative variability, which persists even with a high number of repetitions [15]. In the present study and in agreement with other precedents there were very different values for most parameters, especially with regard to mean concentrations of dissolved oxygen, total coliforms and fecal coliforms.

Given the large range of values indicated in the bibliography, the concentration of most analyzed parameters falls within the range of values found by other researchers. It should be noted for the TGW the case of chlorides, BOD5 and fecal coliform. There were analysed the chlorides while in the bibliography it is presented the total chlorine, which appears with higher concentration values. The value of BOD5 found is substantially lower than those found in the literature, which is indicative of a lower concentration of organic matter in this sample. For fecal coliform, the value found is higher than the values referenced in the bibliography which indicates larger faecal contamination.

With respect to LGW, the parameters values analyzed are in the range of values referenced in the bibliography, with the exception of fecal coliform which showed higher values in this campaign and the conductivity that was lower (294 mS / cm) to that presented by ERIKSSON ET AL, [16] (> 700 mS / cm). However, this group of researchers related this value with the high conductivity presented in drinking water from Copenhagen. The same authors argue that the increase of the electrical conductivity is accompanied by an increase in COD, adding that this may indicate the presence of cations (eg Na +) used in soaps and anions (eg Cl-) used in other types of products such as disinfectants. Also in this work the drinking water conductivity showed a considerable value

Table 1: Values of the parameters analyzed in the TGW, LGW and drinking water.

Parameters analyzed	Drinking water	TGW 1ª	TGW 2ª	LGW	National legal/regulatory VMR	National legal/regulatory VMA	EPA (2004)	Bibliography*
Aluminium (mg/L)	**0,06**	**5,8**	**5,1**	**1,1**	**5**	**20**	_	_
Arsenic (mg/L)	**<0,01**	**0,01**	_	**0,01**	**0,1**	**10**	_	_
Barium (mg/L)	_	**0,02**	**0,02**	**0,02**	**1**	**10**	_	_
Bore (mg/L)	_	**0,20**	_	**0,2**	**0,3**	_	_	**0-3,8**
Cadmium (mg/L)	**<0,001**	**0,07**	_	**0,02**	**0,01**	**0,05**	_	_
Calcium (mg/L)	**4,8**	**9,0**	**12,0**	**8,0**	_	_	_	_
Lead (mg/L)	**<0,005**	**0,1**	_	**0,1**	**5**	**20**	_	_
Clorets (mg/L)	**17,8**	**72,0**	**83,0**	**51,0**	**70**	**-**	_	**$10^{(1)}$**
Cupper (mg/L)	**0,07**	**0,16**	_	**0,4**	**0,2**	**-**	_	_
Chromium (mg/L)	**<0,002**	**0,1**	_	**0,1**	**0,1**	**20**	_	_
Iron (mg/L)	**0,02**	**0,48**	**0,63**	**0,93**	**5**	_	_	_
Phosphorous (mg/L)	_	**8,0**	_	**2,0**	_	_	_	**$0,1\text{-}170^{(3)}$**
Mg (mg/L)	**4,8**	**6,0**	**7,0**	**5,0**	_	_	_	_
Mn(mg/L)	**0,02**	**0,10**	**0,10**	**0,1**	**0,2**	**10**	_	_
Ni (mg/L)	**<0,006**	**0,10**	_	**0,1**	**0,5**	**2**	_	_
Nitrates (mg/L)	_	**2,0**	**4,0**	**2,0**	**50**	**-**	_	**$0,05\text{-}74^{(2)}$**
Selenium (mg/L)	_	**0,05**	_	**0,05**	**0,02**	**0,05**	_	_
Sodium (mg/L)	**14,8**	**200,0**	**170,0**	**48,0**		_	_	**7,4-641**
TSS (mg/L)	**0,0**	**51,0**	**85,0**	**15,0**	**60**	_	_	**40-720**
Sulphates (mg/L)	**27,3**	**130,0**	_	**14,0**	**575**	_	_	_
Zinc (mg/L)	_	**0,11**	**0,10**	**0,22**	**2**	**10**	_	**0,09-6,3**
COD (mg/L)	_	**720,0**	**770,0**	**270,0**		_	_	**8000**
BOD_5 (mg/L)	_	**170,0**	**310,0**	**140,0**		_	_	**90-360**
TOC (mg/L)	_	**160,0**	**260,0**	**1100,0**		_	_	**30-880**
Total Coliform (UFC/100mL)	_	**$13,0 \times 10^7$**	**$48,0 \times 10^6$**	**$4,9 \times 10^6$**		_	_	**$70\text{-}4 \times 10^7$**
Fecal Coliform (UFC/100mL)	_	**$43,0 \times 10^4$**	**$3,7 \times 10^3$**	**$8,2 \times 10^4$**	**100**	_	**ND/100ml**	**$1\text{-}9 \times 10^4$**
Helminthes (nº/L)	_	**0**	**0,0**	**0,0**		_	_	_
***Salmonella* (UFC/100mL)**	_	**0**	**0,0**	**0,0**	**1,0**	_	_	_
RAS	_	**13,0**	**51,0**	**18,8**	**8,0**	_	_	_

(1) Total Cl; (2) Total Nitrogen; (3) Fosfates; ND – Not detectable

* [17];[18];[19];[20]; [10]; [21]; [22]; [23].

VMR- Maximum Recommendable Value; VMA- Maximum Admissible Value

Table 2: Values of the parameters analyzed in the TGW, LGW and drinking water.

Parameters analyzed	Drinking water	TGW 1ª	TGW 2ª	LGW	National legal/regulatory VMR	National legal/regulatory VMA	EPA (2004)	Bibliography
pH	**6,8**	**8,9**	**7,1**	**6,9**	**6,5-8,4**	**4,5-9,0**	**6,0-9,0**	**6,4-8,7**
O_2 (mg/L)	**-**	**7,8**	**1,3**	**1,9**	**-**	**-**	**-**	
T (ºC)	**-**	**20,0**	**11,0**	**16,5**	**-**	**-**	**-**	
POR (mV)	**-**	**-**	**204,6**	**164,6**	**-**	**-**	**-**	

Conductivity(µS/cm)	**168,0**	**-**	**-**	**294,0**	**1000,0**	**-**	**-**	**82,0-1565,0**
TDS(mg/L)	**-**	**-**	**-**	**188,2**	**640,0**	**-**	**-**	**-**

In the second campaign, the amount of dissolved oxygen has been substantially lower than the one of the first campaign, a result consistent with the values obtained for COD and BOD_5, which is higher in this campaign. In fact, the dissolved oxygen decreases or disappears when the water gets large amounts of biodegradable organic substances, since most of the microorganisms responsible for its degradation are aerobic.

As shown by the results presented, LGW still contain large amounts of organic matter and are heavily contaminated with microorganisms (values greater than 10^4 cfu/100 mL).

Analyzing the results from the legal point of view of water reuse for irrigation, it could be argued that the concentration of most parameters in the TGW is not an obstacle. Unlike the aluminium concentration, total suspended solids and chlorides which is above the VMR and the concentration of cadmium which is above the VMA, limiting the direct use of effluent for this purpose. It should be noted that the value of chlorides of drinking water also was substantial. Also in the LGW, most of the parameters shows concentration values that do not limit their application in irrigation. There are, however, some whose concentrations are an obstacle to this application as is the case of fecal coliform, cadmium and copper, whose values are presented above the VMR and selenium with value equal to the VMA. RAS, in this case shows values above the VMR of water for irrigation, thus indicative of a high salinity.

With regard to microbiological parameters, total and fecal coliforms, these waters are highly contaminated and it is not allowed its direct application in irrigation.

In terms of urban reuse, BOD_5 and fecal coliform limit its direct application.

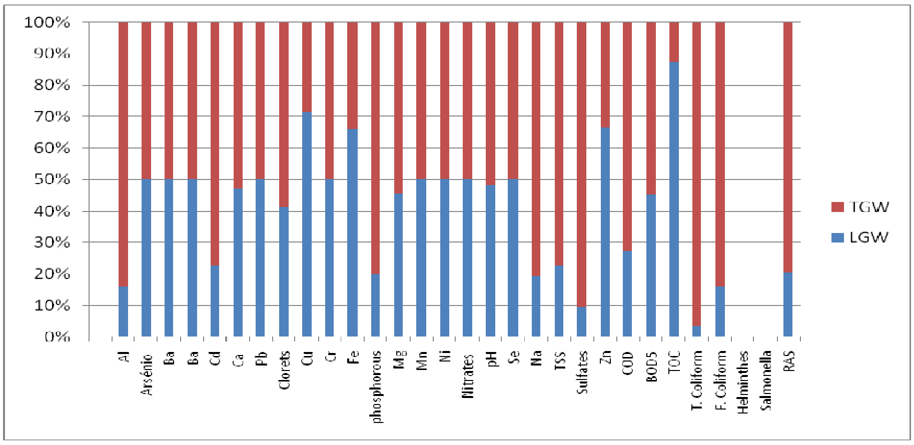
Although the results are not statistically significant, given the small number of samples analyzed, it is possible to make a comparison between the TGW and LGW (Fig. 2). In general and as it would be expected, the concentration of the parameters analyzed in the TGW is superior to the LGW. There are, however, some exceptions such as copper (Cu), iron (Fe), zinc Zn) and total organic carbon (TOC), where the concentration is greater in the LGW. For the microbiological parameters, aluminium, cadmium, phosphorus and sodium, TSS, sulfates, COD and RAS concentration difference between the LGW and TGW is evident, and is significantly higher in TGW. The statistical significance of these results is relative, since the concentrations values of the parameters is highly variable depending on several factors: since the type of use to the type of detergent used, however, it is most evident pollutant and contaminant load in TGW than in LGW, in particular at the microbiological level, and, in principle, it is easier to treat LGW in order to obtain an effluent for reuse. This finding is in agreement with other referenced work ([24]; [25]; [22]).

3.2 GDD characterization

As said before, samples from raw greywater were analysed for pH, conductivity, TDS and COD. In Table 3 there are presented the mean values of each parameter (n=8) by appliance, as well as its standard deviation.

To investigate the concentration of bacteria in raw greywater we enumerated total and faecal coliforms (Table4). Comparing the mean values of pH recorded for drinking water of different houses with greywater from different sources, it appears that with the exception of greywater from the tub and sink, this value is higher in greywater.

Fig 2: Relative concentrations of each parameter in TGW and LGW.



The higher pH values recorded for the water from the washing machines and dishwashers is possibly due to the type of detergents used in the washing. The standard deviation does not assume, in this case, very relevant values. Washing machines and dishwashers reveal again the highest values with respect to conductivity. In fact, the water from the dishwasher has values 20 times higher than the drinking water and water from the washing machine, 50 times higher. The remaining values are close to those recorded for drinking water. The results for this parameter lead to very high SDT values especially in these two domestic devices. It should be noted the high value of standard deviation associated with these results. Microbiological contamination of total and fecal coliforms is always very significant, with the exception of washing machine that did not presented any fecal coliforms, whatever the dilution used.

Analyzing Fig. 3 it can be seen that the domestic devices from kitchen and laundry, are the main pollutant concentration producers, although the bath also contained significant amounts of fecal coliform. In fact, the greywater from the kitchen may contain numerous micro-organisms from the food washing and is usually the most polluted source.

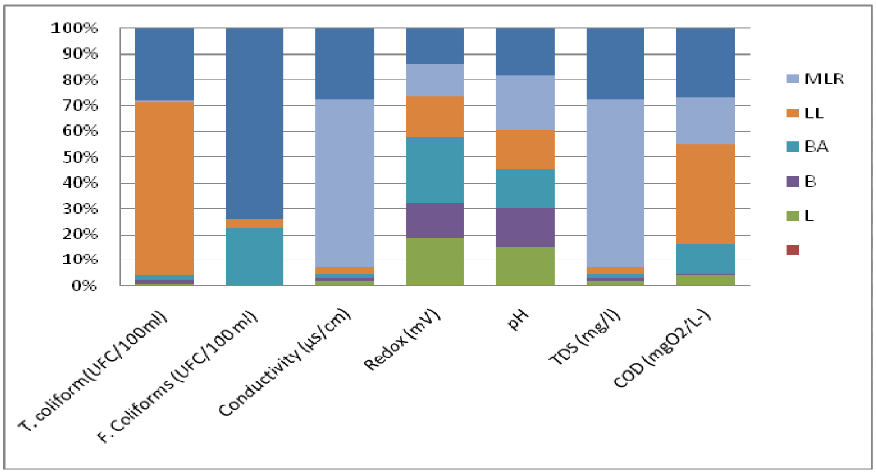
Table3. Pollutant concentration per domestic device.

Source	pH	COD (mg/l)	Condutivity (µs/cm)	TDS (mg/l)
Kitchen Sink	7,3±0,5	1781,5	150,1±105,8	96,1
Washing machine	10,1±0,3	821,1	3677,1±2826,4	2353,4
Dishwasher	8,5±1,7	1234,5	1560,8±833,8	998,9
Wash basin	7,1±0,5	196,8	100,9±21,1	64,6
Bidet	7,3±0,3	7,9	67,5±17,1	43,2
Bath/shower	6,7±1,1	540,2	94,6±42,3	60,6
Drinkable water	6,7±0,8	-	71,9±73,5	46,0

Table 4. Total and Faecal coliform concentration in each domestic device.

Source	Total Coliforms (CFU/100ml)		Fecal Coliforms (CFU/100ml)	
	Mean	SD	Mean	SD
Wash basin	$5{,}43 \times 10^4$	$3{,}53 \times 10^4$	$3{,}33 \times 10^2$	$5{,}16 \times 10^2$
Bidet	$1{,}73 \times 10^5$	$6{,}05 \times 10^4$	$2{,}17 \times 10^2$	$3{,}87 \times 10^2$
Bathtub	$2{,}22 \times 10^5$	$1{,}10 \times 10^5$	$4{,}45 \times 10^4$	$6{,}04 \times 10^4$
Kitchen sink	$6{,}74 \times 10^6$	$3{,}31 \times 10^5$	$7{,}00 \times 10^3$	$8{,}85 \times 10^3$
Washing Machine	$5{,}72 \times 10^4$	$4{,}00 \times 10^4$	ND	ND
Dishwasher	$2{,}82 \times 10^6$	$2{,}62 \times 10^5$	$1{,}50 \times 10^5$	$1{,}67 \times 10^5$

Fig. 3: Relative concentrations of each parameter in each domestic device.



MLR- Washing machine; LL- Kitchen sink; BA- Bathtub; B- Bidet; L- Washbasin;

The COD values are high, with the exception of water from the bidet, reaching a maximum of 1781.5 mg / l in the sink. Most of the COD derived from the chemicals used and is therefore higher in the laundry and kitchen, with great variations from house to house.

Analyzing the results obtained with the purpose of water re-use for irrigation and urban uses, it could be said that:

• Water for irrigation, requires its improvement and so the separation of sources, distinguishing those which contains a high pH (MLL and MLR). Excluding these waters it is produced a clear greywater with a pH in the range of 6,5-8,4, with features for use in irrigation, under the law[12],[26].

• With regard to urban reuse, EPA, [14]recommends a pH value between 6 and 9;

• The values of conductivity and TDS present in the MLL and MLR render the direct reuse of water for irrigation, under Decree-Law 236/98, which refers to maximum recommended 1000 mS/cm;

• The existing regulatory standards relating to the urban re-use, have no limits on the concentrations of COD, but have a limit of 10 mg / L for BOD concentration. As the concentration of COD is elevated and it is an indicative parameter of organic matter presence, it will be assumed that the value of BOD in these waters is high also prevent their re-use without prior treatment;

• With regard to microbiological parameters, it make impossible their direct reuse of effluent in irrigation or urban uses.

3.3 Quantitative Characterization of greywater produced by Domestic device

In Fig. 4 is represented the percentage of water generated by each domestic device.

The capitation found for all sanitary appliances was 114.7 L/person.day, corresponding 95.7 L/person.day to total greywater and 48.6 L/person.day to light greywater.

The study results indicate the great variability associated with the use of some of the sanitary appliances studied, including the MLR, the MLL, the bathtub and the kitchen sink. The high deviations from the average readings for the MLL and MLR are related on the one hand to the fact that the machines were not connected every day and so there were many days of zero consumption. On the other hand, it is related to the type of program used. It should be noted that the sample on the washing machines is not representative, since only one house was equipped with these device. With respect to the tub, the large deviation result on the different habits of the consumers, including the bath duration and the use of water during the same (close or not the tap during soaping).The kitchen sink has a high value of standard deviation, due possibly to the lifestyle of consumers. The fact that consumers lunch and dinner away can lead to significant deviations from the average. As it has been demonstrated is the bath that is associated with higher value of capitation, followed by the kitchen sink and toilet flushing. The wash basin and the machines occupy a lower share of consumption. These results differ somewhat from those reported in PNUEA, since the latter is associated with 41% of total consumption to flush, followed by 39% to baths and showers. However, the percentage of baths and showers provided by PNUEA [19] comes into consideration with the intake valves in the general, without specifying what their origin, and may include a sink and bidet. In this study, washing machines also occupy the lowest-ranking of consumption. Table 5 shows the range of values (maximum and minimum) referenced by Friedler [10] concerning the diverse bibliography compiled by this researcher.

Fig. 4: Percentage of water generated by each domestic device.

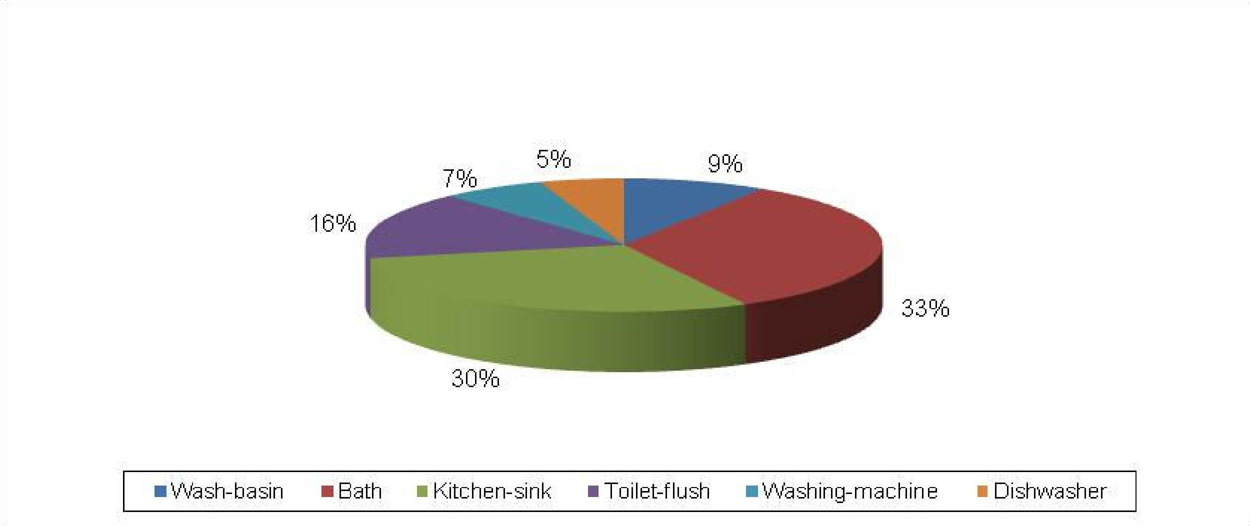


Table 5: Capitation values found in this study and its comparison with others found in similar studies, in other countries.

DOMESTIC DEVICE	UNITS	RANGE OF VALUES	MEAN VALUE	FRIEDLER (2004)	NSW (2006)
Bath	**L/person.day**	**27,8-48,2**	**38,2**	**12-20**	**193**
Wash Basin		**7,1-12,9**	**10,4**	**8-15**	**28**
Kitchen sink		**17,4-50,6**	**34,0**	**13-25**	**44**
Dishwasher		**1,3-10,7**	**6,1**	**2-6**	
Wahing machine		**5,1-19,1**	**7,5**	**13-60**	**135**
Total		**48,5-41,5**	**96,2**	**48-126**	**400**

Table 5 also cite the data proposed by the NSW, [27], which can serve as a comparison. On this basis we can see that the realities vary greatly. The value of total greywater per capita found in this study falls within the range of values that appears in the bibliography.

After made a brief analysis on the provision of greywater, will be interesting to examine whether this is sufficient to meet the demand for in situ re-use. Moreover, knowing the needs, it will be possible to know if it can be reused only the greywater of best quality.

3.4 Characterization of water demand for some urban non-potable applications

Taking into account the values found in this study, the average associated with the toilet-flushing in a house, considering the average household size in Portugal of 3.1 inhabitants per dwelling [13], is 58.59 L/house.day, with a maximum of 75.64 L/house.day and a minimum of 41.54 L/house.day. These values are clearly lower than those referenced in PNUEA that points to the 124 L/house.day. Consequently, it can be concluded that greywater reuse in toilet-flushing, would consume only 20% of the total greywater generated within the dwelling or, if it is chosen to use only the clear greywater, this unit would represent 39 % of this resource.

Regarding car-washing, this study will only treat the domestic car-washing. The urban Portuguese consumers preferably wash their cars in automatic stations, however, where the type of housing permits, the wash is done using the pipe, and this consumption is important to study. This study came to the conclusion that it would take 147 L/house.month for car-washing or about 5 L/house.day. In fact, the frequency of washing obtained in this study is 1.45 washes / month with an average of 5.45 minutes per wash. This portion of consumption, although small is perfectly substitutable for greywater. According to PNUEA, [19], assuming that a wash with pipe lasts an average of 10 minutes at a flow rate of 15 L / min and with a frequency of washing of 2 washes per month, it can be get a consumption of 10 L/house.day, that is double that obtained in this work.

The maintenance of garden areas and lawns requires a significant amount of water, depending, however,on its geographic location and season. In summer, for example, this volume may represent 60% of the total consumption of a dwelling. Analyzing in detail the domestic component, can be considered that watering is done only in the 6 months of low rainfall (April to September). In this study it was concluded that the need for irrigation in those months, would be 6794 L/house.month, implying 226.5 L/house.day, one volume, again, easily replaced by greywater, though storage is needed in the months of lower demand. Investigations revealed an average frequency of use in 30 irrigations per month with an duration average of 11.5 minutes per irrigation. According to the PNUEA in the 5 months of lowest rainfall the averages needs of water in a garden located in Portugal are 0.2 m^3/m^2/month. According to data from INE (1999), 64% of Portuguese homes are houses, of which 30% have outdoor space and garden or lawn with an average of 40 m^2/habitação. Thus, the average consumption per yard will be 40 m^3 per year. According to this plan, in these months, irrigation consumes 266.7 L/house.day, slightly higher than that found in this paper. In Israel, Friedler (2004) states that the reuse of greywater for gardens would need 8-10 L/person.day, or 24,8-30 L/house.day taking in account the average size of the cluster for Portugal. Here it is shown the variability resulting from geographical location and availability of water resources.

Table 6 depicts the amounts of greywater generated by type (supply) and demand for non-potable uses considered.

Table 6: Amounts of greywater generated by supply and demand for non-potable uses.

Greywater generated (L/house.day)	**TGW**	**296,7**
	LGW	**150,7**
	Bath	**118,4**
	Washbasin	**32,2**
Demand (L/house.day)	**Toilet-flushing**	**58,6**
	Car-washing	**5,0**
	Irrigation	**226,5***

In conclusion, depending on the type of housing and green areas, the provision of greywater is enough to supply the water consumption in toilets, car-washing and to supplement irrigation.

4. Conclusion

The results showed that in a reuse perspective it would be best to separate the greywater from the kitchen and laundry of the other sources in order to obtain a clear greywater that would in itself have a better quality. In any case it would have an exempt treatment, even simplified.

Depending on the type of housing and the amount of landscaped green areas, the provision of greywater is enough to supply the water consumption in toilets, for car-washing and to supplement irrigation.

There are several possibilities for reuse, which can be considered in order to take full advantage of greywater. The greywater generated in a dwelling, may not be necessary as a whole. Taking into account that the supply is exceeding demand and that the quality of greywater generated can be improved taking into account the separation of sources, it can be assumed the reuse of only part of this water, that is, the one that has the best quality.

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