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An exploratory study on the influence of socio-demographic characteristics on water end uses inside buildings

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HIGHLIGHTS

- Water end use per domestic device in three regions of Portugal.
- Evaluation of possible relations with the socio-demographic characteristics.
- The results found reflect differences in rural and urban lifestyles.
- Significant correlations were found between the water end use per domestic device and some socio-demographic characteristics.

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ABSTRACT

Any strategy of water demand management needs the collaboration of the population involved and so it is important to know how characteristics as residence area, number of residents, presence/absence of children/elders, income level, and educational level, among others, may influence the use of water. Empirical studies that quantify relationship between socio-demographic factors and the water end use patterns inside buildings are still largely lacking.

To help to fill this gap this paper gathers information about the characterization of water end use per domestic device in three regions of north of Portugal with different socio-demographic characteristics. The main research goal was to establish indoor water end use patterns per domestic device and to evaluate possible relations between these patterns with the socio-demographic characteristics of the area where the household is, namely the number of residents, the presence/absence of children/elders, the income level and educational level.

The washbasin is in average the domestic device with more number of uses in a day (responsible for 34% of the total use), close followed by the kitchen sink (32%), the toilet flush (23%), the bathtub (6%) and finally the dishwasher (3%) and the washing machine (2%). The results found might reflect differences in rural and urban lifestyles once that, with the exception of the kitchen sink, Valpaços is the city that registers the lowest number of uses in the appliances monitored. Significant correlations were found in the following cases: between the residence area and the number of uses in washbasin and in the toilet flush; between the presence of children in the household and the use in the dishwasher; between the income level and the number of uses in the washbasin, in the bathtub, in the washing machine and in the dishwasher.

1. Introduction

The sustainable management of water has become a central issue to be discussed specially in countries with predicted or in water stress. Portugal has a high potential in water resources, but not all are available to use due to an unsuitable temporal and spatial distribution. Besides, Portugal is already in the rank of countries with medium water stress (10%–20%) compounded by high values of water use inefficiency, mainly in agriculture but also in urban areas (Melo-Batista, 2002).

The amount of water needed for domestic consumption in developed countries, is around 100 to 180 l/person/day, which corresponds to 30–70% of the amount of water required in an urban area (Friedler et al., 2005).

In order to achieve sustainable water demand management (WDM) that is defined as the practical "development and implementation of strategies aimed at influencing demand" (Willis et al., 2011a), it is imperative to know in detail how water is used inside buildings.

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Any strategy of water demand management has to have the collaboration of the population involved and so it is necessary to know how characteristics as residence area, number of residents, presence/absence of children/elders, income level, and educational level, among others, may influence the use of water. In fact, past research has determined that water consumption within households is dependent on numerous factors (Hadjikakou et al., 2013; Willis et al., 2011a; Tortella and Tirado, 2011; Niccolucci et al., 2011; Jorgensen et al., 2009; Inman and Jeffrey, 2006). There are socio-demographic factors namely owner occupied properties, income level of the families and household composition (presence of garden and swimming-pools) that are proved to influence water consumption (Loh and Coghlan, 2003; ARCWIS, 2002; Mayer and DeOreo, 1999).

Willis et al. (2011b), evaluated the impact of household makeup on end use water consumption and have concluded that there is a general decrease in consumption per capita as family size increases. In fact, in principle, a higher number of people living in a household lead to a better economy of scale. Arbués et al. (2003) argue that there is an optimum household size, and that beyond a specific edge these economies of scale tend to disappear.

Researchers working with domestic water consumption models have proven that, in general, higher water prices lead to lower consumption (Shaw, 2005). However, the price elasticity of water demand varies according to the use given (Reynaud, 2003). The more basic and essential is the use, the closer to zero is the price elasticity of this demand. As a result, price mechanisms would not make a great difference in the demand (Dalhuisen et al., 2003; Renwick and Green, 2000). Nauges and Thomas (2000) stated that elderly presenting lower incomes show more vulnerability to water price mechanism.

In some countries, the price of water do not seem to influence water consumption since residential water demand is largely price rigid because of its relative cost when compared to other life essentials (Worthington and Hoffman, 2008). This does not seem to be the Portuguese reality, especially in cities in the interior part of the country that register low incomes compared with the national average and where water has a very high price. For the same reasons, the income level is another factor that may have effect on water use. There is, however, some research that demonstrated this factor have a bigger influence on external uses in internal water consumption (Mayer and DeOreo, 1999). In a recent study, Willis et al. (2011b) concluded that lower income households were show to consume less water contrarily to high and middle to upper household income.

It is widely accepted that domestic water consumption is positively correlated with income (Hoffmann et al., 2006). However, if on the one hand higher levels living standards imply a higher quantity of water consuming appliances and the presence of high water demanding external uses (Cole, 2004; Domene et al., 2005), on the other hand, income affects significantly on the responsiveness to price mechanism. In other words, while low income families may not respond to price because they are using water only for basic needs, high income families fill to respond to the price signal, once it is not strong enough to reduce their consumption (Corbella and Pujol, 2009).

Gregory and Di Leo (2003) researched and found that in past findings, higher income families tended to be more involved in pro-environmental activities, had greater concern for the environment and participated to a greater extent in conservation activities that lower income families did. However, their results in 2003 indicated that households with greater awareness and involvement in the decision to use water were older, had lower income and educational levels, and had fewer people living in the household.

Gilg and Barr (2006) carried out a study and the results showed that aged individuals, who own their home, with democratic and liberal political ideas and who are members of community groups, are more committed with water efficient use. This contrasts with non-ecological individuals who tend to be young men, with low incomes and a low level of education, who are less involved with the community and politically apathetic (Mondéjar-Jiménez et al., 2010).

The educational level may also have impact on water use since the water use patterns highly depend on the consideration of sustainable water consumption practices, and on the understanding of its importance to environment itself (Hassell and Cary, 2007). Furthermore, environmental behaviour is also affected by situational influences like the educational level (Jorgensen et al., 2009).

Previous water consumption investigation indicates that persons that are wealthier, older and live in new and larger households consume more (Kim et al., 2007; Kenney et al., 2008). Willis et al. (2011b) determined that the location of household, lot size, rain water tank ownership, household income and household makeup do influence end use water consumption (Willis et al., 2011c). In respect with the socio-economic region of households Willis et al. (2011b), selected and compared four socio-economic groups in distinct regions, and found out that the middle to high group was the one that registered the highest total per capita consumption. However, in this study it was not possible to know for certain which end uses are potentially affected by the socio-economic region. Generally these investigators concluded that lower socio-economic groups tended to slightly use more water inside buildings than those in higher socio-economic groups transversely most end uses categories.

Murdock et al. (1991), defended that the age structure of a given population is a relevant driver of domestic water consumption. Older people may show more saving attitudes and the young might use water less carefully, have more showers and demand more frequent laundering (Nauges and Thomas, 2000).

These works presented important results, however empirical studies that quantify relationship between socio-demographic factors and the water end use patterns inside buildings are still largely lacking within the current body of knowledge.

To help to fill this gap this paper gathers information about the characterization of water end use per domestic device in three regions of north Portugal that have significant differences considering socio-demographic characteristics. This was established by a case study using a representative sample of the local community. The main research goal was to establish indoor water use patterns per domestic device and to relate these patterns with the socio-demographic characteristics of the area where the household is, namely the number of residents, the presence/absence of children/elders, the income level and educational level.

1.1. Case study

1.1.1. Geographical and socio-demographic framework

The study was developed in three Portuguese municipalities each with one representative of a distinct level of the Northern regional urban system, with different classifications in terms of Eurostat's urban–rural typology (Fig. 1), and with some significant demographic and socioeconomic differences (Fig. 2).

Oporto, with a population of 237,591 inhabitants, is the core of the country's second biggest metropolitan area and plays the role of regional capital of the North region of Portugal. It has a relatively old age structure (presenting an ageing index of 194[1]) and in terms of employment is heavily dependent of the tertiary economic sector. Its resident population presents a relatively high level of educational attainment (23% of population with tertiary education) and has a

[1] Ageing index = [(number of people aged 65 and over) / (number of people aged 0–14)] × 100.