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ScienceDirect

Procedia Engineering 119 (2015) 820 – 827

Procedia Engineering

www.elsevier.com/locate/procedia

13th Computer Control for Water Industry Conference, CCWI 2015

Assessment of water use efficiency in the household using cluster analysis

Catarina Jorge[a]*, Paula Vieira[a], Margarida Rebelo[a], Dídia Covas[b]

[a]*National Laboratory for Civil Engineering, Lisbon, Portugal*
[b]*Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal*

Abstract

Concerns over the efficiency of household water use have been increasing worldwide: water is intensively consumed with high inefficiencies. Detailed methodologies for the assessment of consumers' behaviour that include the level of efficiency comparatively to their peers (i.e., similar socio-demographic characteristics) are needed to increase public awareness and to develop strategies related to the efficient use of water. This paper presents a methodology for evaluating the efficiency of indoor domestic water use based on peer comparison. Peer groups were established through cluster analyses according to their relevant socio-demographic characteristics. Finally, the most efficient consumers were identified and water efficiency levels were determined for individual households.

Peer-review under responsibility of the Scientific Committee of CCWI 2015

Keywords: Water use efficiency; household; domestic consumption; cluster analysis; socio-demographic variables

Nomenclature

H_E	Household efficiency level [%]
Cl	Cluster average or minimum [litres]
C_{CD}	Consumption based on consumers' data [litres]

* Corresponding author. Tel.: +351 912 549 675.
E-mail address: cnjorge@lnec.pt

Peer-review under responsibility of the Scientific Committee of CCWI 2015
doi:10.1016/j.proeng.2015.08.945

1. Introduction

The influence of socio-demographic characteristics in the domestic water consumption has been analysed and observed by many authors [1,2,3]. Some of these studies report that the householders are enabled to compare their water consumption profile with other neighbouring households in the same district, street, building or DMA. However, this type of comparisons does not lead to accurate results, since consumers characteristics can be very distinct [4]. According to [5], any strategy of water demand management needs the collaboration of the population involved, as it is important to know characteristics such as residence area, family dimension, presence or absence of children and/or elders in the household, income level and instruction, among others, that may influence the use of water.

Another important question to be answered is "if water conservation is more likely when individuals believe that water is scarce or when they perceive that other consumers are also conserving water" [5].

In several studies, surveys have been conducted to obtain socio-demographic information of each household, which allows clustering consumption by varying demographic indicators [6,7]. These relations are very similar to what is found for the efficiency of energy use, since socio-demographic variables are also considered to influence energy consumption.

Regarding the few studies that do exist on this matter [8-10], it seems that older people tend to spend less water *per capita* than the younger. Moreover, families with children and teenagers are expected to use more water, but mainly in external uses [8]. However, [9] research also shown that older people tend to spend more time at home which leads to higher water consumption. Within the demographic variables, the number of people living in the household appears to be the most important driver of consumption [10].

The current research work presented herein is part of a comprehensive methodology to assess the overall households' water use efficiency, which also comprises an evaluation based on efficient patterns and on the performance evaluation of water use devices [11]. These three analyses should be applied in a complementary way to assess most aspects of water efficiency in the household. Results obtained with this research contribute to promote a more efficient use of water and, concurrently, to support water utilities in the optimisation of water supply systems, thereby increasing the services' sustainability and the provided quality.

2. Methodology

The developed peer comparison methodology aims to propose a novel type of efficiency assessment, in which consumers are compared with each other through their own consumption data. This methodology is a four-step procedure as presented in Fig.1.

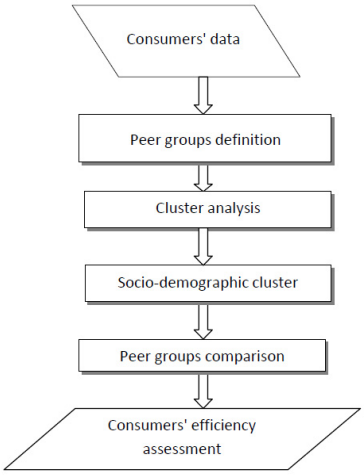

Fig.1. Peer comparison methodology.