

Potential of water loss reduction in distribution systems – Case study focusing in Brazilian regional service providers

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Abstract: This work studies three Brazilian regional water service providers in order to evaluate their operational water loss reduction potentials. A Data Envelopment Analysis (DEA) was produced in order to determinate the amount of water loss that could be reduced in Minas Gerais, Paraná and São Paulo, where the main operation is conducted by regional firms. This analysis was realized using the *Sistema Nacional de Informações sobre Saneamento* (SNIS) – a Brazilian sanitation data system. Based on the inputs (a) connections per network length, (b) family units per connection and (c) family units average consumption, it was possible to identify, via DEA, the efficient water loss – variable considered as a bad output – in the distribution systems. The results indicate efficient values, which would imply in a 12.1 p.p., 9.5 p.p. and 9.9 p.p. water loss reduction in the regional operators of Minas Gerais, Paraná and São Paulo, respectively.

Keywords: Water loss; regional providers; DEA.

The losses in water supply systems are waste of natural, operational and financial resources. With the growth of environmental awareness and sustainability in the sector, mainly promoted by scarcity, the relevance of water loss combat in water supply sector has become more evident. Lambert and Hirner (2000) states that water loss determinates the efficiency in the distribution process, once fast increasing and high levels of its index are correlated with unsatisfactory operational planning and maintenance, and thus inspiring a water loss control program implementation.

In this sense, considering the relevance of cities characteristics and nuances, and their different improvement opportunities, this work's objective is to determinate the potential amount of water that could be recovered in the distribution. The case study consider the following Brazilian regional water service providers: *Companhia de Saneamento de Minas Gerais* (Copasa), *Companhia de Saneamento Básico de São Paulo* (Sabesp) and *Companhia de Saneamento do Paraná* (Sanepar).

To achieve this objective was used the SNIS, a data base referring to water services at 2015. The methodology used can be divided into two stages: (i) selection of the study sample and (ii) determination of the potential of water loss reduction by service provider through DEA.

The sample selection (i) was performed considering municipalities with feasible losses from water distribution systems (between 0 and 100%) and micro and macro-measurement index above 99%, considering that, in this study, the reliability of measurements is prerogative for the application of DEA. Thus, 300, 363 and 332 municipalities operated by Copasa, Sabesp and Sanepar, respectively, were selected for analysis. As a consequence of this first methodological step, 128 municipalities were not sampled because their micro and macro-measurement index are less than the desirable. As these municipalities do not measure all the volume produced and/or

consumed, they should receive specific treatment from the regional providers in order to measure these volumes in their totality.

The municipalities sampled, it means, those with at least 99% of micro and macro-measurement, form the basis to apply DEA (ii). This tool allows determining the potential of water loss reduction in each municipality, based on the characteristics and capacity of each water supply service provider to operate systems with lower losses. Therefore, these municipalities should prioritize the planning and execution of actions to reduce the water losses, observing the results obtained from this study.

Data Envelopment Analysis is a mathematical tool. This tool allows obtaining an efficiency frontier based on productive units and it considers the production and the necessary inputs (MELLO *et al.*, 2005). Therefore, this study evaluated the efficiency by water loss in the distribution index (output) and the inputs considered were (a) connections per network length, (b) family units per connection and (c) average consumption per family units. These inputs were chosen because verticalization, consumption and length of the supply network are related with water loss index, as explained by Galvão (2007). Furthermore, Lambert and Hirner (2000) explain that the actual amount of water lost in the distribution system depends on several factors: topography, network length, number of connection and, mainly, system management. In a well-operated system, water losses are continuously monitored and controlled.

Therefore, as a product of the second methodological stage (ii), the analysis indicated a water loss index reduction potential of 12.1 p.p, 9.5 p.p and 9.9 p.p, in Minas Gerais, Paraná and São Paulo, respectively. Thereby, the Plansab target (29%) for water loss index would be fully attained in these states, because Copasa, Sanepar and Sabesp would achieve 25.1%, 23.8% and 23.3% water loss index, respectively.

In addition, the methodology proposed enables the identification of priority municipalities for investment in losses. Finally, considering the municipalities' sample of this study, if the service providers reach the target proposed, it will be possible supply 3.4 million people daily with the water that would be lost.

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