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Evaluation of the water supply system of Pombal – PB

Evaluación del sistema de suministro de agua de Pombal - PB

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Abstract: Considering the importance of water in the functioning of life on earth, and as a limited resource, we see with concern the waste and losses that occurred in public water supply systems. In this sense, this work seeks to evaluate the conditions of supply systems in the municipality of Pombal in the State of Paraiba. Therefore, the analysis of secondary data collected from the National Sanitation Information System (SNIS) was considered, we considered information and rates of losses in distribution, losses in revenue, population served, per capita consumption, and volumes of water produced, consumed and billed in the period 2010 to 2019. The results show that the city has a slow tendency to reduce real and apparent losses, an adequate per capita consumption; trend of increased demand due to population growth, reduction of the volume of water produced and increase in volumes consumed and billed. . Based on the results, it is concluded that: there should be greater investment to accelerate the reduction of losses; efforts to reduce losses are indispensable so as not to have to increase water production in the same proportion; it is not recommended to continue the reduction of per capita consumption so as not to compromise the minimum conditions of hygiene and maintenance of health; and finally, the trend presented by the volumes produced, consumed and billed need to be maintained so that the city's indicators continue to improve and are among the best in the region or country.
Keywords: *Sanitation; Loss indices; Production; Consumption; Distribution.*

Resumen: Teniendo en cuenta la importancia del agua en el funcionamiento de la vida en la Tierra, y como recurso limitado, nos preocupan los residuos y las pérdidas que se producen en los sistemas públicos de abastecimiento de agua. En este sentido, este estudio pretende evaluar las condiciones de los sistemas de abastecimiento de agua en el municipio de Pombal, en el Estado de Paraíba. Para ello, se basó en el análisis de datos secundarios recogidos del Sistema Nacional de Información de Saneamiento (SNIS), considerando la información y los índices de pérdidas de distribución, pérdidas de facturación, población atendida, consumo per cápita y volúmenes de agua producida, consumida y facturada en el periodo de 2010 a 2019. Los resultados muestran que la ciudad presenta una tendencia lenta de reducción de las pérdidas reales y aparentes, un consumo per cápita adecuado; tendencia de aumento de la demanda debido al crecimiento de la población, reducción del volumen de agua producida y aumento de los volúmenes consumidos y facturados. Con base en los resultados, se concluye que: se debe hacer una mayor inversión para acelerar la reducción de las pérdidas; se debe hacer un esfuerzo para reducir las pérdidas de manera que no sea necesario aumentar proporcionalmente la producción de agua; no se recomienda la continuidad de la reducción del consumo per cápita para no comprometer las condiciones mínimas de higiene y mantenimiento de la salud; y, por último, se debe mantener la tendencia que presentan los volúmenes producidos, consumidos y facturados para que los indicadores de la ciudad sigan mejorando y se mantengan entre los mejores de la región o del país.
Palabras clave: *Saneamiento; Ratios de pérdidas; Producción; Consumo; Distribución.*

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INTRODUCTION

Water is a natural resource essential to life on the planet, and it plays a fundamental role in environmental and socioeconomic aspects, since it is the basis for the development of almost all human activities.

Although the planet is predominantly composed of water, the small percentage of freshwater usable for consumption reveals a scenario of scarcity of this resource in the world, motivated by irregular distribution, water stress, especially in regions located in arid zones, and pollution.

Given the importance of this resource, it is necessary that public and private managers evaluate the efficiency and effectiveness of their supply systems, before adopting solutions that exclusively address the expansion of water transport and treatment infrastructure (BEZERRA; PERTEL; MACÊDO, 2019). This statement is corroborated by Barroso (2019) who points out that the increase of works in basic sanitation in Brazilian municipalities, will depend on improvements in management, especially the situation considered dramatic of water losses in the public supply systems of municipalities.

The public water supply system is intended for the production and distribution of drinking water, in quantity and quality compatible with the needs of the population, for consumption purposes. In this sense, the reduction of waste and losses emerges as a fundamental element for the management of water resources, especially in regions where water is a limiting factor, where demand exceeds supply.

According to Bezerra, Pertel and Macêdo (2019) in Brazil, of the total water produced by sanitation companies in 2016, about 38% was lost in distribution, between real and apparent losses. Real losses are due to various types of leaks in water supply systems (WSS), while apparent losses originate from clandestine connections and defective or fraudulent hydrometers (ALEGRE et al., 2005).

MIRANDA (2002), points out in his study that the uncontrolled growth of water losses in the supply systems is due to the sum of the following factors: few investments, less technological development; a culture of increasing supply and individual consumption; pragmatic decisions, to increase the load and extend the networks to more peripheral areas of the systems, to serve the new consumers. It also emphasizes that the reduction of losses enables a better use of the existing infrastructure and the postponement of the application of resources to expand the systems.

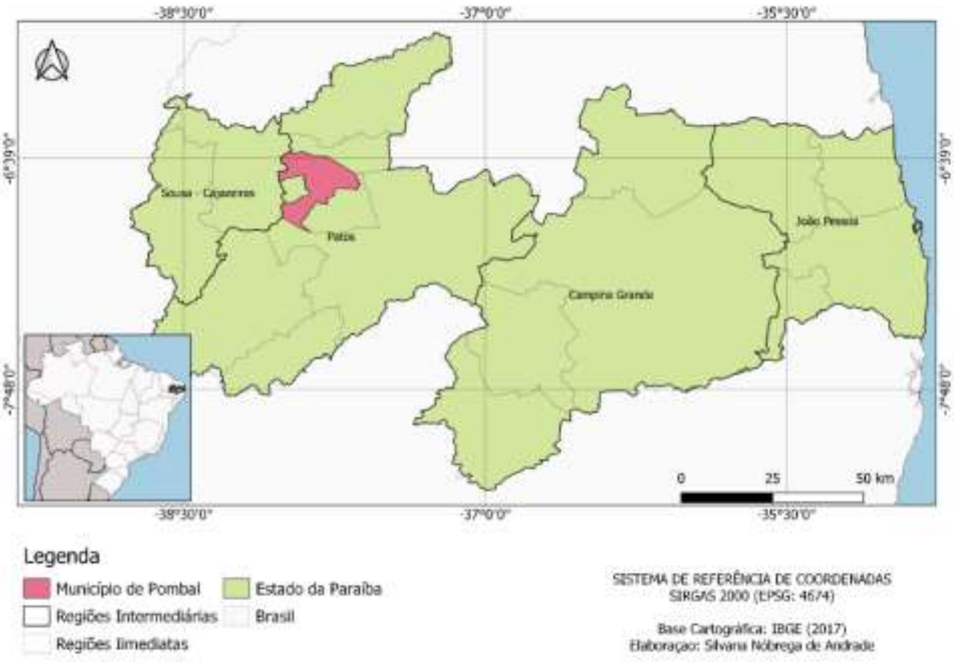
Given the importance of the theme, this paper aims to portray the conditions of water loss management in water supply systems in the municipality of Pombal in the state of Paraíba.

METHODOLOGY

Characterization of the study area

The Figure 1 presents the study area that comprises the municipality of Pombal in the state of Paraíba, located more precisely in the Patos Intermediate Geographic Region and Pombal Immediate Geographic Region, according to the regionalization proposed by IBGE (2017).

FIGURE 1: Map showing location of the study area.



SOURCE: Authors (2021).

The population of the municipality in question was about 32,801 in habitants in 2019 according to National Sanitation Information System - SNIS (2020), 0.29% (94 in habitants) of the total population does not have access to water supply services against 99.71% who have access, being above the regional and national average, which present the percentages 75.04% and 83.71%, respectively.

Analysis and Data Collection

The methodological procedures were built from the achievement of some steps necessary for the realization of the research that had a descriptive analysis method and a critical interpretation based on the information collected for better understanding of the theme.

A priori, a survey of secondary data from SNIS was carried out, which deals with the annual diagnosis of water and sewage from 2010 to 2019, in which some indicators were analyzed and, subsequently, Excel was used for data processing and preparation of graphics. The indicators used in this work are described below, as described in SNIS (2020):

Distribution loss index or real losses (IN049)

Refers to all the water made available for distribution that does not reach consumers, and is calculated by equation 1:

IN049 = (AG006+AG018-AG024) / (AG006+AG108-AG024) x 100 [1]

Where: AG006 - produced water volume; AG010 - consumed water volume; AG018- imported treated water volume; AG024 - service volume.

Index of billing losses or apparent losses (IN013)

Refers to the volume of water that was effectively consumed by the user, but that, for some reason, was not measured or accounted for, generating billing loss to the service provider, and is calculated by equation 2:

IN013 = (AG006+AG018-AG011-AG024)/(AG006+AG018-AG024) x 100 [2]

Where: AG006 -Produced water volume; AG011 -Invoiced water volume; AG018 -Imported treated water volume; AG024 -Service volume.

Total population served with water supply (AG001)

Refers to the total population that uses water from the public water supply system. This information is provided by each supply company.

Per capita consumption (IN022)

This per capita consumption is the daily average, per individual, of the volumes used to satisfy domestic, commercial, public and industrial consumption, and is calculated by equation 3:

IN022 = (AG010-AG019)/AG001 x 1.000.000/365 [3]

Where: AG001 - Total population served with water supply; AG010 - Volume of water consumed; AG019 - Volume of treated water exported.*Volume de água produzido (AG006).*

It is defined as the average volume of water available for consumption, produced exclusively by the operator, measured directly at the outlet of the WTP. In other words, it is information passed on by the supply company that operates the system.

Volume of water consumed (AG010)

All the water consumed by users, including the micro-measured and estimated volumes (without or with broken hydrometer) and the volume of treated water exported to another service provider. This information is made available by the supply company.

Billed Water Volume (AG011)

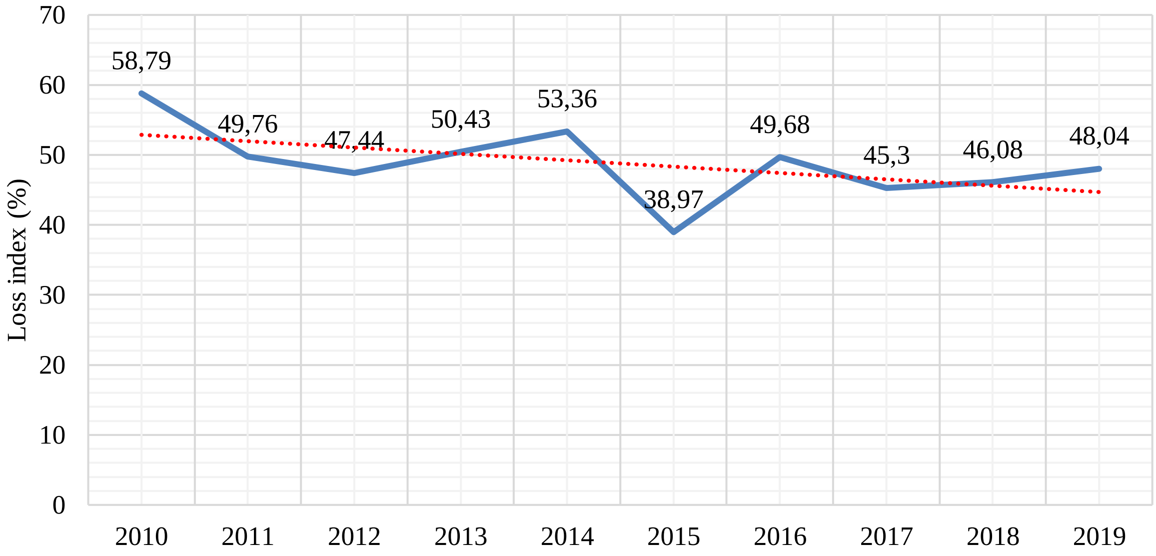
It is defined as the average volume of water, charged to the total of metered and unmetered savings, for billing purposes.

RESULTS AND DISCUSSION

Losses in the Distribution (Real Losses)

The distribution loss rate, suffered some oscillations in the period, but dropped from 58.79%(2010) to 48.04% (2019), remaining still above the national average (39.24%), and the state average (38.78%) in 2019, according to SNIS (2020), as presented in Figure 2.

FIGURE 2: Distribution loss index (2010 to 2019) in the city of Pombal - PB.



SOURCE: Adapted from SNIS (2020).

It is noteworthy that in the period analyzed, the data indicate a trend of reduction of this loss, in the order of 1.07 p.p. per year. This slow reduction in losses suggests a need for greater investments to combat losses by monitoring the supply networks.

As Silva and Conejo (2003) report, these losses originate in leakages in the system, involving abstraction, raw water adduction, treatment, reservoir, treated water adduction and distribution, in addition to operational procedures such as washing filters and flushing the network, when these cause consumption higher than that strictly necessary for operation.

These same authors report that the reduction of these losses allows production costs to be reduced - by reducing the consumption of energy, chemicals and others - and to use existing facilities to increase supply, without having to expand the production system. These losses must be combated, because if nothing is done, the volumes of water lost will grow naturally, as pipes deteriorate and the number of leaks in networks and branches gradually increases (ABES, 2015).

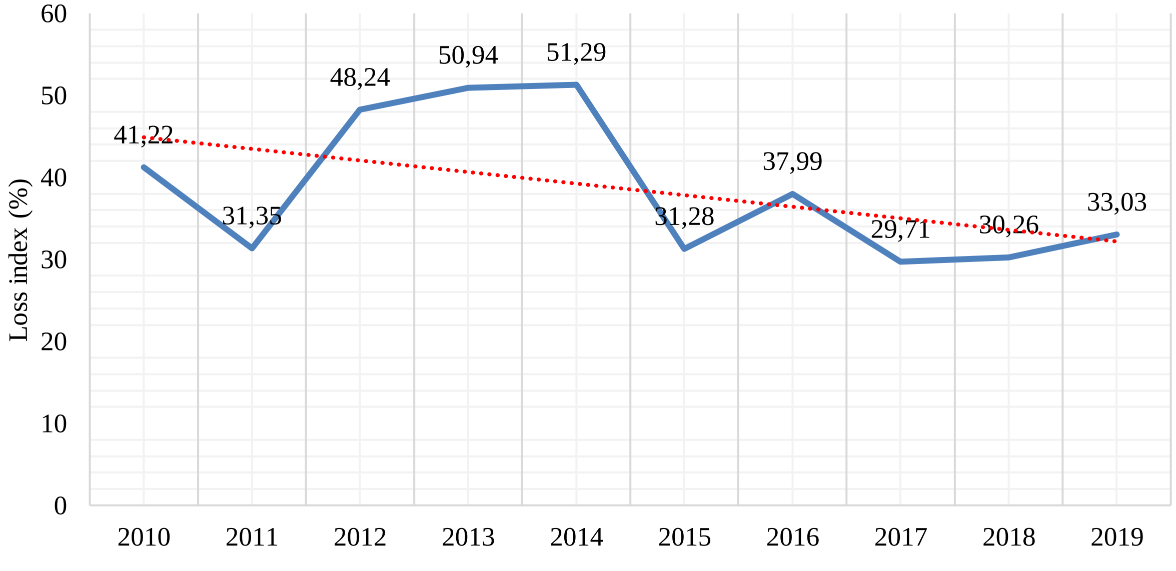
The concern with water losses should start in the "design" and "construction" phases of water distribution systems, with actions such as: conception of the sectorization x piezometric plans, the positioning of registers and valves, the specifications of materials and equipment and the quality of the execution of services and works (ABES, 2015). The reduction of this type of loss brings as main consequence, the production of a smaller amount of water to supply the same amount of people, having the operator a reduction of various costs, such as chemicals, electricity, labor, etc. (ABES, 2013).

Among the actions to reduce this type of loss we can mention: pressure reduction, quality of materials and execution of the work, research of non-visible leaks and reduction of repair time (FUNASA, 2014).

Losses in billing (apparent losses)

The loss in billing index, presented in Figure 3, suffered oscillations in the period, but reduced from 41.22% (2010) to 33.03% (2019) staying slightly below the national average (37.39%), and above the state average (25.37%) in 2019, according to SNIS (2020).

FIGURE 3: Index of loss in billing in the period from 2010 to 2019 in the city of Pombal - PB.



SOURCE: Adapted from SNIS (2020).

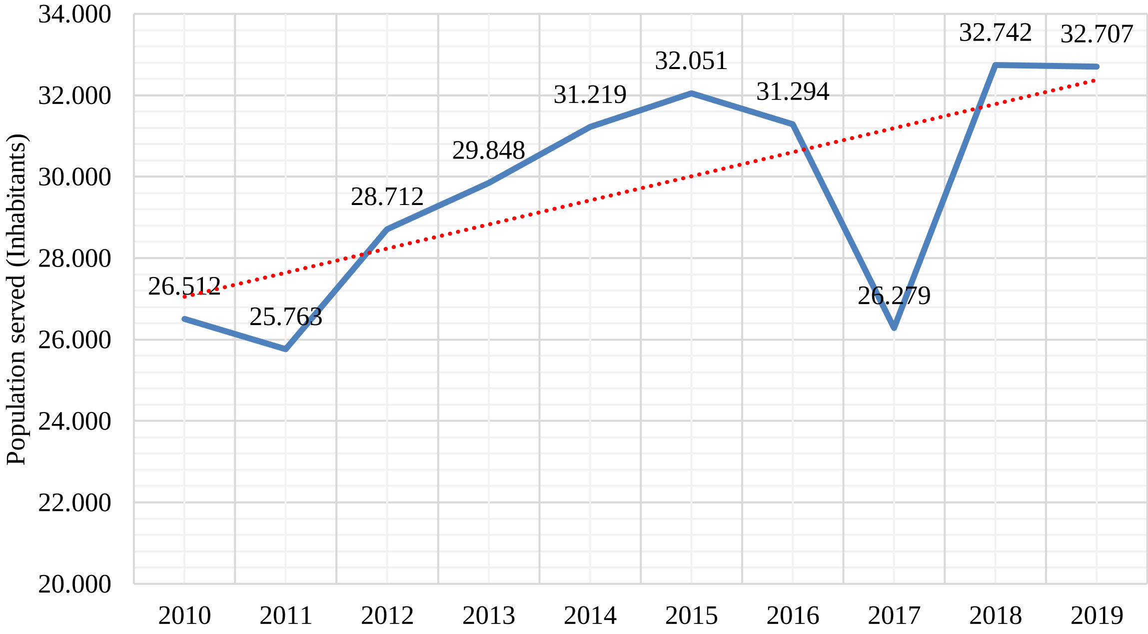
It is noteworthy that in the period, the data indicate a reduction trend of these losses, of approximately 0.8 p.p. per year. As reported by ABES (2013) cities in Germany and Japan have loss rates of around 11%, and Australia has 16%, i.e., we are still far from reaching rates recorded in developed countries.

These billing losses, also called non-physical losses, originate from clandestine or unregistered connections, stopped or fraudulent hydrometers, among others (SILVA; CONEJO, 2003). These same authors report that the reduction of these losses implies a reduction in the volume of unaccounted water, requiring the adoption of measures to reduce physical and non-physical losses, and their maintenance at an adequate level, taking into account the technical-economic feasibility in relation to the operational process of the entire system. Like distribution losses, these losses also need to be combated, because water meters wear out over time and the functioning of the meter's internal mechanisms is impaired, increasing sub-metering; and by defrauding a connection, and not suffering any reaction from the operator, the customer encourages other customers to the same procedure, increasing fraud losses (ABES, 2015). The reduction of this type of loss has as its main consequence the increase in the billed volume, and consequently, the revenue (ABES, 2013). Among the actions to reduce this type of loss we can mention: proper installation of macro meters, calibration of flow meters, adequate commercial management system, fight against fraud, control of inactive and clandestine connections, quality of labor, installation of hydrometers appropriate for the consumption range, periodic exchange of hydrometers, and de-inclination of hydrometers (FUNASA, 2014).

Population served with supply

The population served with supply, presented oscillations in the period, but increased from 26512 inhabitants (2010) to 32707 inhabitants (2019), that is, an increase of 23.37%, of as presented in Figure 4, indicating a growth trend over time.

FIGURE 4: Population served with supply (2010 to 2019) in the city of Pombal - PB.



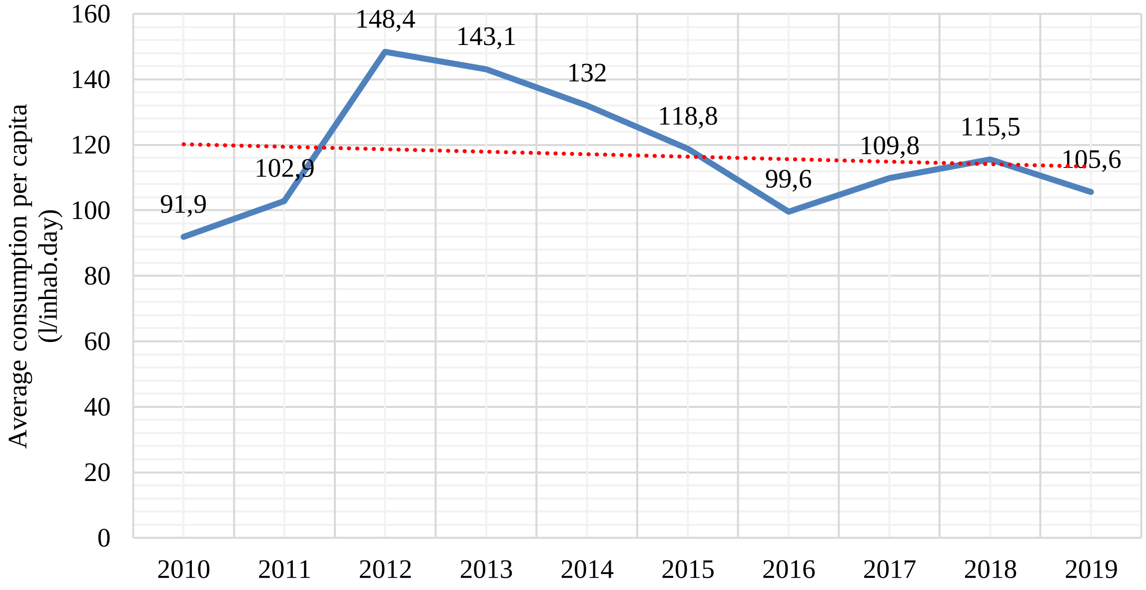
SOURCE: Adapted from SNIS (2020).

This population increase tends to increase the demand for water; occurring two possible actions in this case: increase production capacity or reduce losses. As reported by ABES (2013), between increasing water production capacity and reducing losses, the second alternative will in many cases be the most appropriate from an economic, financial and also environmental point of view.

Per capita consumption

The average per capita consumption of water is the average daily consumption, per individual, of the volumes used to satisfy domestic, commercial, public, and industrial consumption; this is important information for demand projections, for the design of water and sewage systems, and for operational control (SNIS, 2020). According to figure 5, per capita consumption varied from 91.9 to 148.4 l/inhab.day, reaching a value of 105.6 l/inhab.day in 2019, lower than the national average (153.87 l/inhab.day) and the state average (113.44 l/inhab.day).

FIGURE 5: Per capita water consumption in the period (2010 and 2019) in the city of Pombal-PB.



SOURCE: Adapted from SNIS (2020).

Within the decade analyzed, the trend is towards a reduction in per capita consumption, a fact explained by the high values presented between 2012 and 2015. In the period from 2012 to 2019 there was a total reduction of 42.8 l/hab.day, resulting in an average annual reduction in this period of 6.11 l/hab.day.

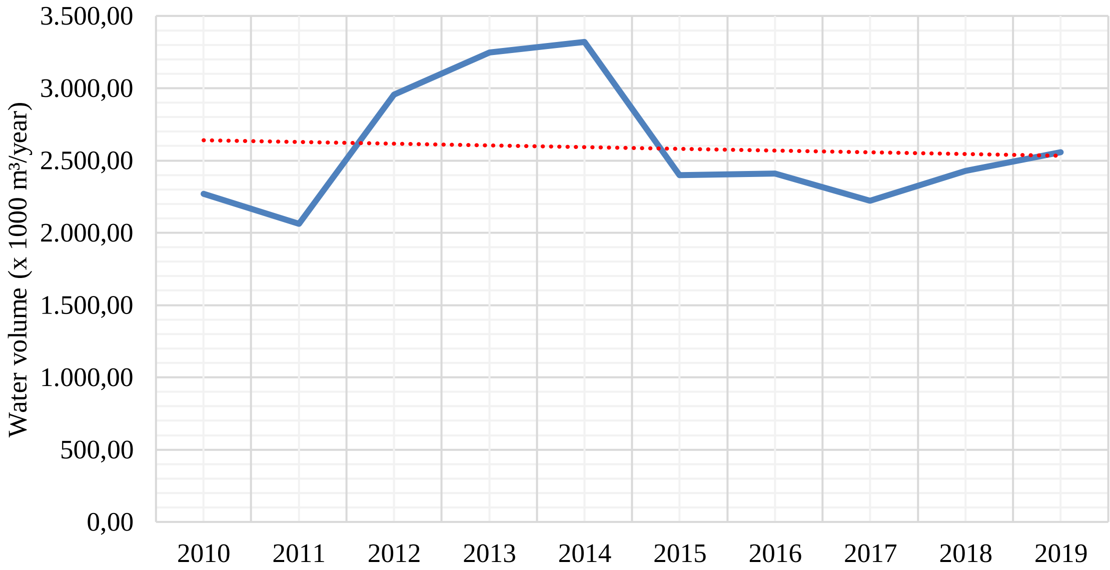
The per capita consumption of the city of Pombal-PB in 2019 was 105.6 l/hab.day , i.e., slightly above the minimum value recommended by the World Health Organization which is 100 l/hab.day (WHO, apud DANTAS el at, 2012), not being indicated that the municipality maintain this reduction, not to be below the recommended value, to be possible to have the minimum conditions of hygiene and health maintenance. According to Heller and Padua (2010) factors such as climate, temperature and family income also contribute to increase per capita water consumption in a municipality.

Among the advantages of reducing per capita consumption, in addition to water and energy sustainability with beneficial environmental impacts, is the increased durability of physical infrastructure, especially pipes (SINS, 2020).

Volume of water produced

The volume of water produced is defined as the average volume of water available for consumption, produced exclusively by the operator, measured directly at the outlet of the WTP, estimated through pitometry or temporary flow recorders (SNIS, 2000 apud CARVALHO et al, 2004). As shown in Figure 6, the volume produced varied from 2,062,200 m³/year to 3,320,270 m³/year reaching in 2019 the value of 2555610 m³/year, presenting a slight reduction trend.

FIGURE 6: Volume of water produced between 2010 and 2019 in the city of Pombal /PB.



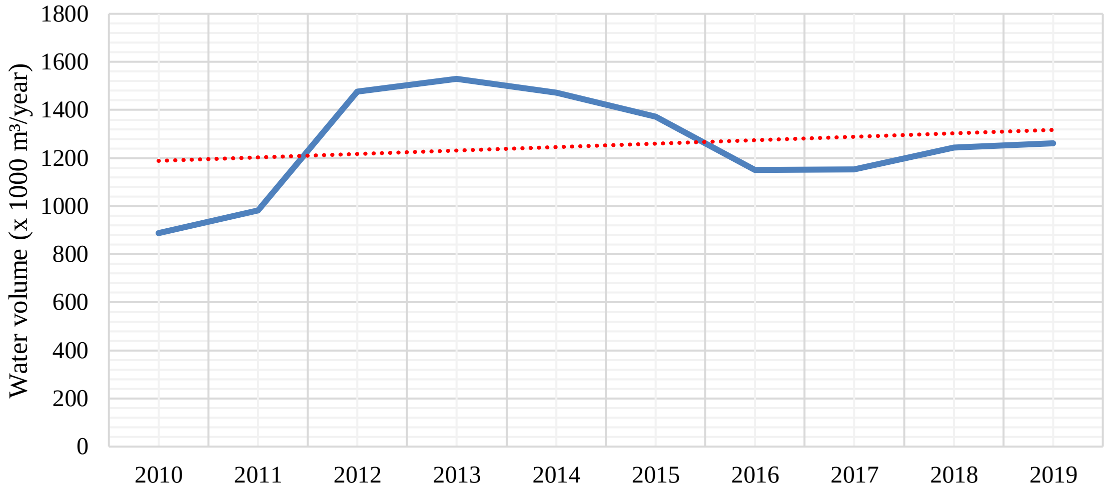
SOURCE: Adapted from SNIS (2020).

In this case, we can attribute this reduction in production, even with an increase in consumption, to the increase in the billed volume (Figure 8) and the reduction in real and apparent losses (Figure 3); this is a positive result that the company should work to maintain over time.

Volume of water consumed

Annual volume of water consumed by all users, comprising the micro-measured volume, the estimated consumption volume for connections without a hydrometer or with a stopped hydrometer, plus the volume of treated water exported to another service provider (ABES, 2015). As presented by Figure 7, the consumed volume varied from 887,890 m³/year to 1,529,470 m³/year reaching 1261520 m³/year in 2019, presenting a growth trend.

FIGURE 7: Volume of water consumed between 2010 and 2019 in the city of Pombal /PB.



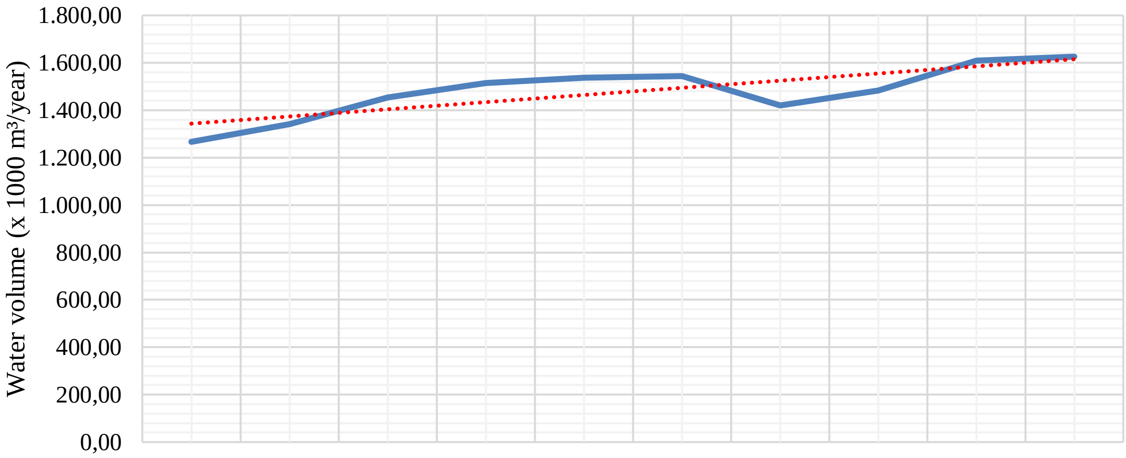
SOURCE: Adapted from SNIS (2020).

In the period analyzed there was a growth in the volume consumed of around 42.08%. It is worth pointing out that this percentage includes unbilled and unmeasured authorized consumption (operational and emergency uses) and unbilled and unmeasured consumption (social uses).

Billed water volume

Billed water volume can be defined as the average volume of water, charged to the total of measured and unmeasured savings, for billing purposes (SNIS, 2000 apud CARVALHO et al., 2004). The annual billed volumes in the period from 2010 to 2019, in the city of Pombal - PB, are presented in Figure 8.

FIGURE 8: Billed water volume between 2010 and 2019 in the city of Pombal /PB.



SOURCE: Adapted from SNIS (2020).

The billed volume varied from 1266590 m³/year to 1625800 m³/year, this being the value for 2019, i.e., an increase of 28.36%, showing a growth trend over time. This is a positive situation for the company, since it implies an increase in revenue.

CONCLUSIONS

In the period (2010 to 2019) the city presented a positive result, of a downward trend, in real and apparent losses, and should invest so that this trend is maintained and accelerated, to reach better results faster. The city has presented a high population growth, generating an increase in demand, and making efforts to reduce losses indispensable, so as not to need to increase water production in the same proportion.

The per capita consumption is at an adequate level, and it is not indicated to continue reducing it over time, so that it does not reach values that can compromise the minimum conditions of hygiene and health maintenance. The reduction in the volume produced, and the increase in the same period, of the volume consumed and billed, are positive results presented by the company, which need to be maintained over time, so that the city's indicators are among the best in the region or in the country.

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