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Simulation of the use of rainwater for car washing at a dealership in Aracaju/SE

Simulación del uso de agua de lluvia para el lavado de coches en un concesionario de automóviles en Aracaju/SE

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Abstract: The demographic and economic growth of a country automatically generates an increase in the demand for water, which consequently promotes a problem that is socially worsening. Faced with this situation, one of the actions that can be adopted in order to save water, and which has become popular in recent years, is the implementation of systems for capturing and reusing rainwater. In view of the above, this article aims to perform a simulation of the capture and use of rainwater in a vehicle dealership located in the city of Aracaju/SE. Initially based on the roof area and rainfall data for the years 2016 to 2020, the volume of water captured by the roof was calculated, and finally, the percentage of consumption that could be met with the use of this water was estimated, in this case, the washing of vehicles, and the impact generated on the local urban drainage network was analyzed. In the analyzed period, the average monthly demand was 30.0 m³, the monthly volume collected by the roof resulted in an average of 301.8 m³ and the average monthly reduction in the volume of water thrown into the drainage network was of the order of 30, 7%. It is concluded that rainwater fully meets the estimated demand, the use of rainwater reservoir positively impacts the drainage network, and for this, it must be used on a large scale.
Keywords: Non-potable use; Drainage; reuse.

Resumen: El crecimiento demográfico y económico de un país genera automáticamente un aumento de la demanda de agua, lo que en consecuencia fomenta un problema que se agrava socialmente. Ante esta situación, una de las acciones que se pueden llevar a cabo para ahorrar agua, y que se ha popularizado en los últimos años, es la implementación de sistemas de captación y reutilización de aguas pluviales. Teniendo en cuenta lo anterior, este artículo tiene como objetivo realizar una simulación de la captación y aprovechamiento del agua de lluvia en una concesionaria de automóviles ubicada en la ciudad de Aracaju/SE. Inicialmente con base en el área del tejado y en los datos de precipitación de 2016 a 2020, se calculó el volumen de agua captada por el tejado y, finalmente, se estimó el porcentaje de consumo que podría ser atendido con el uso de esta agua, en este caso, el lavado de vehículos, y se analizó el impacto generado en la red de drenaje urbano local. En el periodo analizado, la demanda media mensual fue de 30,0 m³, el volumen mensual captado por la cubierta resultó una media de 301,8 m³ y la reducción media mensual del volumen de agua vertida a la red de drenaje fue de alrededor del 30,7%. Se concluye que el agua de lluvia satisface plenamente la demanda estimada, el uso de reservorios de agua de lluvia impacta positivamente en la red de drenaje, y para ello, debe ser utilizado a gran escala.
Palabras clave: *Uso no potable; Drenaje; Reutilización.*

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INTRODUCTION

The demographic and economic growth of a country automatically generates an increase in water demand. Some authors like Hogan et. al. (2010) emphasize in their studies the current difficulties in providing good quality water for human consumption, as well as limiting situations for economic and population growth. According to Braga (2006), the growth of cities was due to job opportunities and promises of improvement in living conditions, especially in urban areas, where industries were installed, influencing population migration to the cities. With this, the reduction in the availability and quality of water, present in the urban context, generated a problem that worsens socially, for some reasons: The increase in residential and industrial consumption that potentiate the pressure and degradation of surface or underground springs; Due to the expansion of the urbanized area and economic concentration (TUCCI, 2008).

Given this scenario, one of the actions that can be taken to save water, and that has become popular in recent years, is the implementation of rainwater harvesting and reuse systems. This system is composed of gutters, vertical and horizontal conductors, filters, and reservoirs (cisterns). The reservoir (cistern) is one of the most important items of the system, and the most expensive, and should be considered in its sizing the implementation costs, water demand, catchment areas, rainfall regime, reliability required for the system, as well as the annual temporal distribution of rainfall (CASA EFICIENTE, 2008 apud LIMA; RESSUREIÇÂO, 2018).

The system also has gutters that aim to collect rainwater that falls on the roofs (catchment areas) and conduct them to vertical and horizontal conductors (LORENZETE; LUIZ, 2011). According to Bressan (2016), vertical conductors consist of pipes or conductors that receive the collected water from the gutters and transport it to the horizontal collectors or interconnection boxes, and horizontal conductors consist of horizontal pipes that conduct rainwater from the vertical collectors to the final destination points, which in this case will be the reservoir.

The rainwater collected is used to flush toilets, irrigate gardens, clean cars and external areas, wash clothes, supply fountains and water mirrors, and as a fire reserve (ABNT, 2007). Among the advantages of using rainwater for non-potable uses, Maia et al (2020) mention avoiding the waste of water taken from natural springs, reducing water bills, and helping to contain flooding in large cities, after all, the captured water no longer flows into the streets.

In view of the above, this article aims to simulate the capture and use of rainwater in a car dealership located in the city of Aracaju/SE, by estimating a non-potable demand, estimating the volume that can be captured, and verifying that the estimated non-potable use will be met.

THEORETICAL FOUNDATION

For a long time, water was treated as an infinite resource. However, as abundant as it may seem, it is insufficient to meet a demand that never stops growing, especially when considering the current scenario of pollution, degradation and waste (GARCIA et al., 2010).

The United Nations World Water Resources Development Report 2015, the degradations that have occurred in ecosystems in recent years due to the accelerated function of urbanization, inadequate agricultural practices, deforestation and pollution of water bodies, are among the factors that affect the environment's ability to provide water in satisfactory quantities to sustain life on the planet (UN, 2015).

According to Fernandes, Medeiros Neto, and Mattos (2007, p. 4) "UN data indicate that in a few years about 50 countries will face extreme water shortages that will affect an average population of 2.8 billion people. One realizes the importance of reusing water so that in the future it will not be a scarce material, since sustainability ensures that future generations have the goods essential to human life.

Due to the constant increase in population, water scarcity in some areas becomes more common, in urban centers near the coast. There are several reasons that justify the increased demand for new alternatives for the use of water reuse, the limited availability of fresh or drinking water and because it is a sustainable alternative (environmentally, socially, and economically). Another way to justify the use is local characteristics, for example, the cost of effluent disposal, the cost of potable water, and environmental protection. It is a common practice to use reused water. It can be divided into two categories: non-potable and potable. The non-potable category can be used in agricultural, industrial, municipal and environmental recreational activities (ABES, 2015).

In Brazil, the PURA program (Program for Rational Use of Water) was created by Sabesp, which aims to encourage the rational use of water with technological actions and cultural changes. To reduce water consumption, solutions are based on several actions, including leak detection and repair, exchange of conventional equipment for more modern and economical ones, studies for water reuse and educational lectures (BRASIL, 2015).

The Brazilian Standard (NBR) 15527/2019 of the Brazilian Association of Technical Standards (ABNT) rainwater is "the water resulting from atmospheric precipitation on roofs, rooftops, where there is no movement of people, animals or vehicles". According to Tomaz (2010):

> Rainwater harvesting is always used as non-potable water, used for garden watering, yard cleaning, toilet flushing, vehicle washing, industrial uses, fire pond use, and other uses that do not require potable water. There is a way to estimate residential potable water consumption using engineering parameters. The

great difficulty in applying engineering parameters is the large amount of information needed and not always available.

Responsible consumption includes a series of measures that should be taken to make people aware of having a different attitude. Adopting technologies to reuse rainwater can avoid harmful consequences to water resources (NEGREIROS et al., 2010).

METHODOLOGY

Study Area

Pres. Tancredo Neves, 1550 - Jardins, Aracaju - SE, which displays and sells vehicles, but also provides other services such as repairs and washing.

FIGURE 01: Car dealership in Aracaju/SE.

SOURCE: Own author (2022).

Estimation of non-potable use

In this work we adopted a non-potable use to be served with rainwater and the washing of vehicles. According to Carvalho Júnior (2020), the average consumption of 150 liters/vehicle wash will be adopted. During an on-site visit it was informed that the company performs a monthly average of 200 washes, resulting in a monthly average of 30,000 liters (30 m³).

Coverage Area

For an estimate of the roof catchment areas the Google Earth Pro tool was used. A total coverage area of approximately 4411.0 m² was obtained. It is worth noting that this value refers to the horizontal projection of the roof (Figure 02), thus resulting in approximate values.

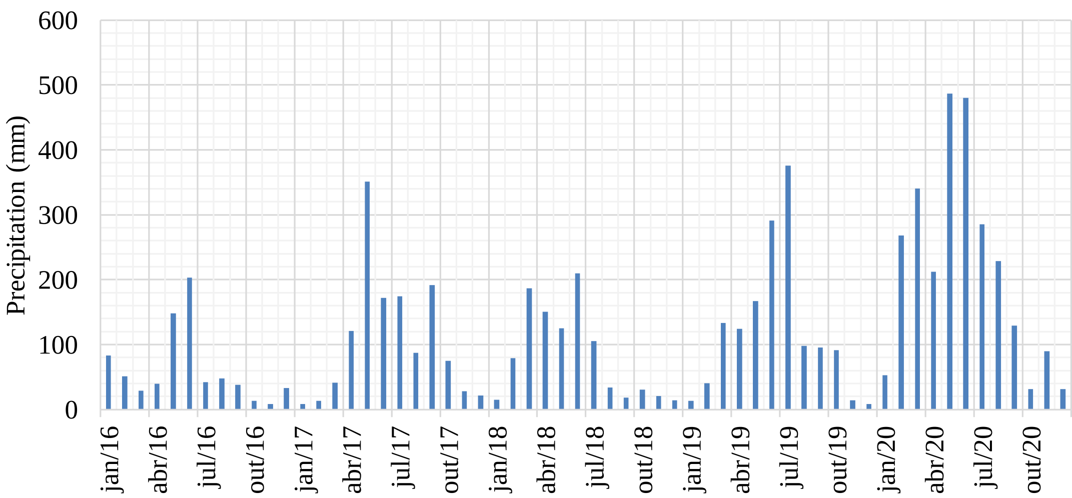
FIGURE 02: Coverage area (catchment) of a car dealership in Aracaju/SE.

FONTE: Google.com.br/googlemaps (2022).

Rainfall data

Monthly rainfall data recorded in the city of Aracaju/SE for the period January 2016 to December 2020 (Figure 03) totaling 60 months will be used.

FIGURE 03: Monthly precipitation (mm) in Aracaju/SE in the years 2016 and 2020.



SOURCE: National Institute of Meteorology (2022).

Volume of rainfall captured each month

To determine the volume of rainfall captured by the roof each month, the equation in Tomaz (2003) was used:

$$Q = A \times C \times (P - I) \quad (1)$$

Where: C is the surface runoff coefficient, adopted 0.80 (ceramic tiles); P is the monthly precipitation, in millimeters for the period January 2016 to December 2020 (Figure 03); I is the interception of water that wets the surfaces and losses by evaporation, usually 2 mm; A is the collection area (roof area), in square meters; Q is the monthly volume produced by rainfall, in liters.

Analysis of the impact of rainwater reservoir use on the drainage network

Regarding rainwater harvesting reservoirs, Teston (2015) reports that their use for non-potable purposes in buildings can contribute to flood reduction. To simulate the impact of the use of the reservoir, the percentage of reduction of the volume of water thrown into the drainage network will be calculated for each month, according to Equation 2, below:

$$\text{Reduction (\%)} = (V_{CR} - V_{SR})/V_{SR} \quad (2)$$

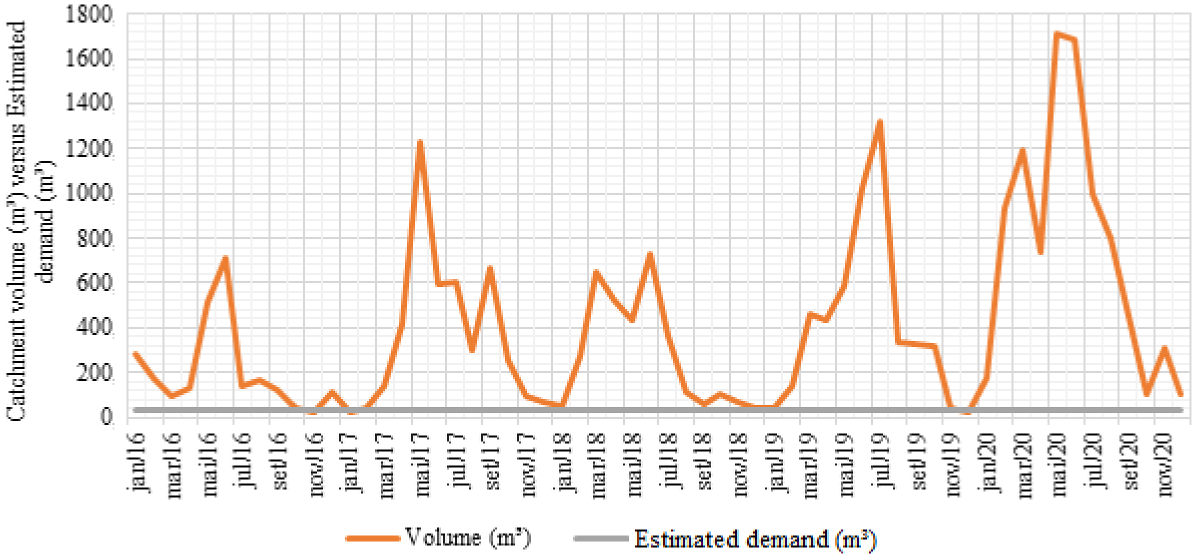
Where: V_{CR} = volume of water thrown into the drainage network with the use of a reservoir (m³); V_{SR} = volume of water thrown into the drainage network without the use of a reservoir (m³).

RESULTS AND DISCUSSIONS

Estimated demand versus volume obtainable

Volume captured by the cover varied from 15.6 m³ (December/2019) to 1259.2 m³ (May/2020) resulting in an average monthly volume of 301.8 m³, a value approximately 13.66 times greater. In the period analyzed, the total water captured by the roof was 18,106.2 m³, much higher than the estimated volume of 1,800 m³ for consumption, i.e. washing the cars. In only six months was the volume of rainfall captured below the estimated monthly demand of 30 m³.

FIGURE 04: Catchment volume (m³) versus Estimated Demand (m³).

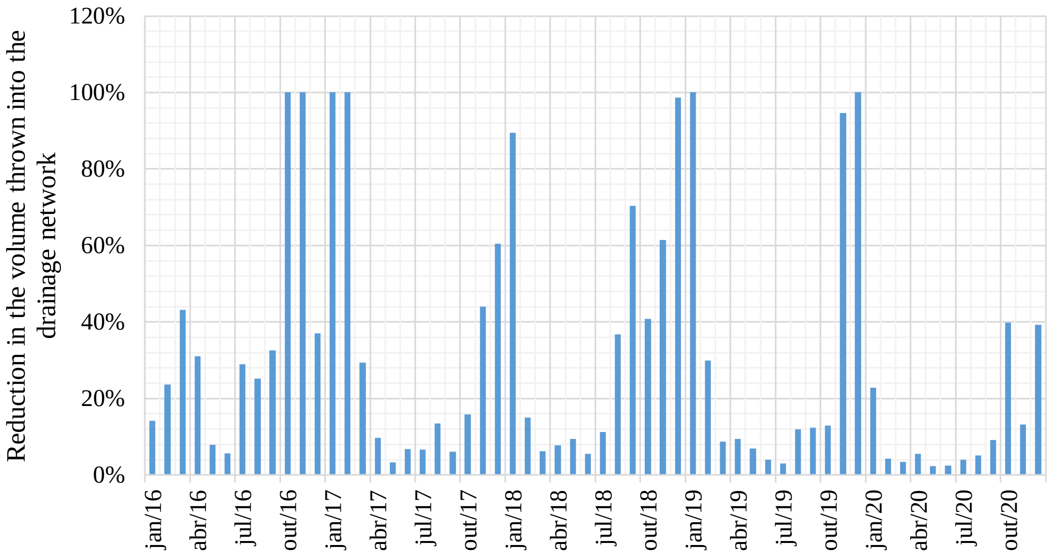


SOURCE: Own author (2022).

Impact of the use of a rainwater storage tank

The simulation results of the reduction of water thrown into the drainage network are presented in Figure 05, below.

FIGURE 05: Percentage reduction of water volume discharged from the urban drainage network with use of a reservoir.



SOURCE: Own author (2022).

In the period analyzed the reduction in the volume of water thrown into the drainage network varied from 2.4% to 100.0% resulting in an average monthly volume of 30.7%. In the rainiest months, the volume of water captured by the cover is much higher than the estimated demand, the reservoir fills up more frequently, and consequently, the volume of overflow into the drainage system is much higher, implying a low percentage reduction. In periods of low rainfall, the opposite occurs, that is, the reservoirs fill less frequently, the volume overflowed is lower - in some months it was zero - and consequently, the percentage reduction is high.

CONCLUSIONS

a) In the simulation performed, rainwater fully meets the estimated demand for car washing, that is, without using other sources, and this fact is justified by the high rainfall index in Aracaju - SE and the large catchment area of the establishment;

b) Considering the average monthly volume captured by the coverage and the estimated demand, it is possible to meet other non-potable demands in the establishment;

c) The use of rainwater reservoirs in buildings can significantly contribute to the reduction of the volume of water thrown into the drainage system,

d) Even in events of higher rainfall, the use of rainwater reservoirs has a positive effect because it delays in the initial instants that this volume of water is thrown into the drainage system, thus reducing the peak flow and increasing the time of occurrence of this flow.

e) For the use of stormwater ponds to have a significant impact on the urban drainage network, large-scale use is required.

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