Rainwater Reuse at the Gonçalo Moniz Institute – FIOCRUZ-BA

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This work aims to evaluate the reduction in water consumption at the IGM/FIOCRUZ-BA facilities, evaluating the potential for rainwater harvesting. To this end, the areas of roofs with the potential for reuse of rainwater were surveyed, their capture capacities considering rainfall data, in addition to a survey of the institution's water consumption. We observed significant results in percentages of reduction in water consumption in the case of rainwater reuse and the potential savings generated when compared with the data effectively spent on the water in the IGM. We observed that the capture capacities of the roofs and the pluviometric indices of Salvador can provide potential savings to the Instituto Gonçalo Moniz (IGM).
Keywords: Rainwater. Precipitation. Reuse.

Introduction

The intended use and consumption of fresh water is one of humanity's most significant challenges and is essential to continue to live sustainably and maintain life on Earth. Water is essential for human existence and the planet's most valuable asset. Approximately 70% of its entire surface is covered with water, with 97% formed by seas and oceans consisting of salt water and only 3% corresponding to fresh water, which can be found in underground reservoirs, rivers, and lakes, and in the humidity of the air [1].

According to the International Water Management Institute [2], the rational use of water and the fight against its waste today is worldwide concerning. The problems associated with water are its uneven geographical distribution, the disorderly population increase, and resource misuse. Studies carried out by the institute estimate that about 1/3 of the world's population will experience extreme effects of water scarcity by the year 2025 [3].

It is also noteworthy that water scarcity in the not-so-distant future causes concern. In debates, when the subject is the environment, a concern to preserve this resource gains strength, emphasizing the importance of water and the sustainability of this water resource for nature [4].

In this context, the SDGs (Sustainable Development Goals) relevant to the 2030 agenda bring within their scope an invitation to the planet to produce actions that will minimize or mitigate poverty and protect the environment to ensure that people can enjoy peace., prosperity, and a more sustainable planet. Within the SDGs, SDG6 has as its premises to ensure the availability and sustainable management of water and sanitation for all [5].

Reusing rainwater is an alternative to the sustainable use of this resource. Rainwater harvesting aims to collect and store rainwater through roofs, gutters, and conduits used for its collection and transport to supply reservoirs that serve applications that do not require drinking water [6]. Thus, this article aims to analyze the rainwater reuse through the roofs of the Instituto Gonçalo Moniz (IGM). We will capture the water and store it to reduce drinking water consumption in activities that allow using non-potable water. Furthermore, as most of the rainwater harvesting will take place through the roofs, it is intended to reduce expenses on the invoices of the concessionaire that supplies water and sewage services, prioritizing so that this whole process occurs by gravity. Thus, they are not necessary for other expenses with electricity

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supply, preserving environmental sustainability characteristics.

Materials and Methods

The IGM/FIOCRUZ-BA is an Institute for the production of science, technological development, and training of human resources in the health area. It is an integral part of the Sistema Único de Saúde (SUS). Therefore, it has socio-environmental obligations that tend to a collective conscience for improving the health and well-being of society.

This work evaluated the reduction of water consumption in its facilities, identifying the potential for capturing rainwater for reuse, its possible use in flushing toilets and urinals, and gardening and maintenance activities. From the methodology used, it was possible to identify alternatives for rainwater harvesting, propose improvements in actions that are already carried out, and suggest their expansion.

To this end, the areas of roofs with the potential for reuse of rainwater were surveyed, their capture capacities considering rainfall data, in addition to a survey of the institute's water consumption through consultations on monthly invoices from the concessionaire providing the service (EMBASA) in the period between November 2020 and October 2021, in order to compare the institution's funding capacity and consumption needs.

Important Considerations

The capture of rainwater in the IGM is intended to be one of the measures taken to reduce water consumption to contribute to the sustainability of the environment, collaborating to maintain this finite natural resource. Furthermore, the environmental theme brings society an understanding of environmental sustainability to enable new ways and solutions to save natural resources that can improve comfort to a more satisfactory level 2.

The significant point is to examine the constitution of the roof's material to verify the fluidity coefficient and prevent the material from contaminating the water captured and stored. Mechanisms such as filters and screens should also be created to avoid clogging through branches and leaves and to facilitate the cleaning of the capture system.

The use of rainwater is an option that can prove to be very attractive for minimizing the effects of water scarcity in large urban centers and the costs generated by the consumption of water obtained from traditional sources [7].

The rainwater harvesting system benefits everybody, bringing advantages through the capture of rainwater to reduce water consumption from the public concessionaire and remove it from public roads since that water could form floods and bring public and private damage [8].

Water conservation can be defined as any action that: reduces water abstraction from springs, reduces consumptive uses, reduces waste or losses, increases use efficiency, increases recycling or reuse, and prevents water pollution [9].

Calculation of the Volume of Water

To calculate the volume of rainwater captured by the roofs and stored in reservoirs, we used the formula of the ABNT Standard, NBR 15527:2019 (below), which depends on the surface runoff coefficient of the roof and the efficiency of the initial runoff average rainfall and roof areas disposal system.

$$\mathbf{V = P \times A \times C \times \eta}$$

In which:

V is the annual, monthly, or daily volume of usable rainwater in liters;
P is the average annual, monthly, or daily rainfall in mm;
A is the collection area in m^2;
C is the surface runoff coefficient of the roof (0.92);
η **uptake factor** is the catchment system's efficiency, considering the solids disposal device and initial flow diversion if the latter is used [10]. η**= 0.85** (recommended by Standard 15527:2019, in case of missing data).

The average monthly precipitation data for the city of Salvador, where the IGM is located, were obtained from the Climatempo website.

Results and Discussion

Potential Areas for Rainwater Collection

To calculate the area of rainwater caught, we inspected the roofs to identify building coverings that allow safe access for frequent inspections and cleaning of the tiles so that the water is collected with as few impurities as possible. The conditions for installing reservoirs were also considered so that they can store water in a place that allows supply through gravity. The architectural projects of the pavilions' roofs were consulted with the unit infrastructure service. We obtained 2.516 m² as the potential area for capture the water (Table 1).

Survey of Rainfall Data

Figure 1 shows the average monthly rainfall for Salvador based on constant rainfall.

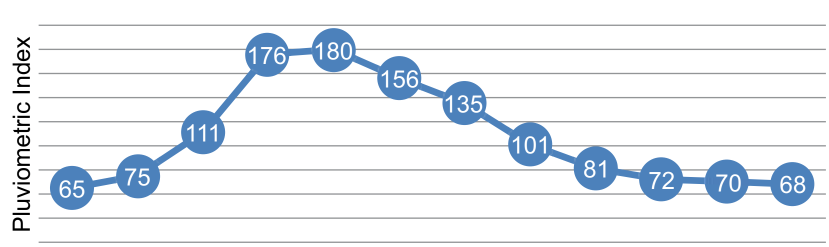
The data presented represent the behavior of rainfall throughout the year. Climatological averages are values calculated from a 30-year observed data series. The monthly volumes of usable rainwater were calculated with the data in hand (Table 2). This information can estimate the amount of non-potable water that can be collected for reuse and consequent reduction of water consumption in the IGM.

Table 2 also shows the amounts in m³ of drinking water consumed and the respective amounts paid that were taken from the invoices of the concessionaire responsible (EMBASA) for the water and sewage supply of the IGM in the period of one year, counted from November 2020 to October 2021. Finally, it is possible to observe very significant

Table 1. IGM roof areas.

Pavilions	Roof's Area (m²)
Silver Aluizio	350
Italo Sherlock (Central)	425
Lain Carvalho (NEB)	260
Zilton Andrade	798
LASP 6	83

Figure 1. Average rainfall in Salvador.



	1	2	3	4	5	6	7	8	9	10	11	12
Months	65	75	111	176	180	156	135	101	81	72	70	68

Source: Climatempo.

Table 2. Calculation of rainwater harvesting value for non-potable use.

Period	P (mm)	Rainwater (m^3)	Drinking water consumed (m^3)	Amount paid for drinking water consumed	% of the potential reduction in water consumption with rainwater reuse
Nov/20	70	137.73	277	BRL 10,444.01	49.72
Dec/20	68	133.79	317	BRL 12,066.56	42.20
Jan/21	65	127.89	639	BRL 24,881.60	20.01
Feb/21	75	147.56	308	BRL 11,675.18	47.91
Mar/21	111	218.39	339	BRL 12,918.65	64.42
Apr/21	176	346.28	389	BRL 14,822.18	89.01
May/21	180	354.15	432	BRL 16,516.73	81.97
Jun/21	156	306.93	252	BRL 9,592.46	121.79
Jul/21	135	265.61	298	BRL 11,249.52	89.13
Aug/21	101	198.72	313	BRL 11,886.45	63.48
Sep/21	81	159.37	310	BRL 11,765.22	51.40
Oct/21	72	141.66	365	BRL 13,920.07	38.81
		2,538.09	**4,239.00**	**BRL 161,738.64**	**59.74**

numbers of percentages of reduction in water consumption in the case of the reuse of rainwater and the potential savings generated when compared to the data effectively spent on the water in the IGM. Another possibility to be evaluated in a later study is its use for drinkable purposes. In a preliminary search in the literature, we identified two evaluations on the subject that show possibilities of using water for this purpose, provided that ways to improve its quality are verified. In an evaluation presented by Hagemann [11], rainwater proved suitable for use in the state in which it was collected. However, eventually, some parameters were exceeded when compared to the legislation. Regarding exceeded values, turbidity and *Escherichia coli* were mentioned, but which, if reduced, would improve the potential for using rainwater. However, the analyses indicated relatively close data when evaluating parameters for collecting water directly from the atmosphere and comparing it with the water collected from roofs. Pereira [12] performed microbiological analyses in another evaluation that showed similar performances. Both rainwater and water from the supply network showed no contamination for the parameters evaluated. However, compared with the legislation on drinking water, it was found necessary to carry out treatment to remove organic matter and eliminate microorganisms.

Conclusion

The capacity of collecting the roofs and the rainfall in Salvador can save 59.74% of the costs paid by the institution for water supply, provided that the water collected can be stored and used for purposes that do not require drinking water. This good economy, in financial terms, can generate reductions of approximately one hundred thousand reais per year in the invoices to be paid by the institution. In view of the perspective of cost reduction, the amount to be saved can be directed to investment in implementing facilities for reusing rainwater on the roofs of buildings, the object of this study. In addition, reusing rainwater is an outstanding contribution to preserving this essential natural resource and the environment. The next phase of the study will be to evaluate the costs for the implantation of the reservoirs and hydraulic installations and the analysis of the quality of it for drinking and other purposes.

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