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Proposal to reduce potable water consumption in a metallurgical industry in the metropolitan region of Curitiba city – case study

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ABSTRACT

This research is based on the need to reduce the consumption of potable water due to the current water scenario allied to the company's socio-environmental situation. The metallurgical industry is the third industrial group with the highest consumption of potable water in the world. This study can be used in other metallurgical industry segments besides residences, public and private works. Currently, the water usage scenario of Curitiba and the metropolitan region is classified as 'quantitative critical', which can cause companies to accelerate the process of water collection through alternative sources. Through surveying potential sources for water collection, three sources of capture and one point for press water were classified. For validation of these potentials, chemical-physical tests were performed on the water samples. Subsequently, reservoir sizing calculations were performed based on the ABNT NBR 15527 standard. Thus, the first idea of reducing potable water consumption was up to 84%, even in the month with the lowest volume of rain.

Key words: conditioner water, lack of water, rainwater, reuse in industry, storage, water reuse

HIGHLIGHTS

- The case study was in a metallurgical multinational company located in an industrial park area. This region has large growth with a critical hydric scenario.
- It counts with different types of water (climatizer, drainage pit, drainage groove, rainwater) storage, also the using of these different types of waters.
- Positive social impact.
- Positive environmental impact.
- Positive economic impact.
- Reduction of potable water consumption for non-potable purposes.

1. INTRODUCTION

The population growth brings an increase in water consumption and decreases the quality of the sources and therefore it contributes even more to an urban supply deficit (Teixeira *et al.* 2016). The United Nations (UN) considers potable water as a finite and fragile resource that is always pressured due to population growth, agricultural and industrial activities. It signals a water deficit in the coming years. If there is no drastic reduction until 2030, we may have a deficit of 40% in potable water.

It is estimated that demand for the supply of potable water in industry between 2000 and 2050 will grow about 400% (UNO 2015). It is notable that the lack of water directly impacts homes and industry. Conama resolution n. 357/2005 (Brazil 2005) regulates the water supply suspension in the industries in case of scarcity, supply to industries can be suspended, prioritizing residential supply. The lack of water is a known problem in some Brazilian regions. To attenuate the high consumption, rain capture has been one of the alternatives encouraged by the governments of some countries (Lee *et al.* 2016). Some specific initiatives and several studies are carried out and published annually, but the theme focused on industry is still somewhat widespread (Thomé *et al.* 2019).

The capture of rainwater can contribute greatly to the increase in the availability of water for consumption by the population. Also, the collection of rainwater is not something new, it is millenary and has been improving more and more

(Campisano *et al.* 2017). Among these, the research leads to the reuse and importance of rainwater. Beyond that, the studies were initiated by analyzing the distribution of potable water consumption in Brazil, with the main focus on the region of Curitiba metropolitan region so it justifies the databases of ANA (National Water Agency) and Sanepar importance during this research.

2. OBJECTIVE

The objective of this paper is to reduce (by at least 30%) the consumption of potable water used for non-potable purposes through the capture, storage, distribution and application of water from alternative sources in non-potable production processes thus increasing the availability of drinking water in the public potable network more directly, benefiting local residents and indirectly the city's population as a whole, and also promoting a reduction in the risk of stoppage in industrial activity due to the lack of this resource.

3. BIBLIOGRAPHIC REVIEW

In this chapter, all the content that allowed the understanding of the history of water abstraction and the science involved in the water cycle was addressed. This served as the basis for the construction of the research, a passage covering different levels, between definitions of water and its importance, abstraction history of rainwater, calculation method for reservoirs, legislation and other related topics.

3.1. Water

The planet Earth is mostly composed of water that is found in different types of states being, liquid, solid, and gaseous. Water is a fundamental resource for life on Earth also it is a resource found in nature in abundance. It has always been exploited without any concerns about its scarcity. As far as it is present in all living beings it is indispensable for life on our planet, it is, therefore, a vital resource for all living beings, such as the human being who can have up to 60% of his weight composed of water, in plants this reaches up to 90%, and in certain aquatic beings this number reaches up to 98% (Bassoi & Menegon 2014). Approximately 75% of the surface on planet Earth is composed of water, so is it possible to talk about water scarcity? However, we cannot say that water will end up on our planet because as long as water is a chemical element it also has mass and is attracted by the force of gravity on our planet. The water on our planet is constantly moving. The amount is invariable for thousands of years, due to the hydrological cycle (Bassoi & Menegon 2014).

The 'Chuá de Educação Sanitária e Ambiental' (BRAZIL) program of the Minas Gerais Sanitation Company classifies freshwater and saltwater. Fresh water represents 2.5% of the planet's total water, with 70% of this water in glaciers and the rest in rivers, lakes, and underground sheets, and saltwater represents 97.5% of our planet's water volume being present in the oceans, which cover about 75% of the Earth's surface. The population growth brings an increase in the demand for potable water, and with this comes the need to seek sustainable practices to optimize water resources (COPASA 2012).

3.2. Importance of water

Potable water is essential for maintaining life on Earth. It is intrinsically linked to the health and even the dignity of the human being. Water is responsible for climate variation and the maintenance of rivers, lakes, and oceans. It provides the conditions for the development of plants and animals, thus reinforcing its concept of the essential resource for life, and it is also a good source of energy for hydroelectric plants, essential for agriculture and it has multiple applications in industry (Ribeiro *et al.* 2017). Even if the world's water does not run out it can be transformed, so the intense use and contamination of water are gradually raising the costs to make it potable again. Thus, becoming an increasingly less accessible resource for the vast majority of the inhabitants of the land. Even today potable water is a resource difficult to access for some regions of our planet. According to the report of the United Nations Organization (UNO 2021) objective 6 of the 2030 development agenda advocates universal and equitable access to clean water and sanitation by 2030. Despite this objective, it is clear that the challenge the UN cites is that three out of 10 people do not have access to clean water, and more than two million live in countries with a very critical water level and about four million people experience a severe shortage of potable water for at least one month of the year. According to the data collected by the national water agency (ANA 2017), Brazil has about 12% of the world's surface freshwater reserves. Table 1 below shows the size of Brazil's water reserve in comparison to other countries.

Table 1 | Water distribution in the world

Distribution of surface potable water in the world	
Africa	9.7%
Americas	40%
Asia	32%
Europe	15%
Oceania	3.9%
Brazil	12% of the world total
	18%*

*Considering contributions from foreign territory. *Source*: ANA (2017).

Although Brazil has an approximate reserve of 12% of the planet's freshwater, the natural distribution of this resource is not balanced, according to the report of the national water agency (ANA 2017) the Amazon region concentrates approximately 68% of the amount of water available and the other 32% are spread throughout the country. This distribution can be seen in (Figure 1).

A factor of great relevance is related to the quality of groundwater and surface water in Brazil. In general, the agricultural, livestock and industrial activity added to deforestation has contributed to poor water quality. In large centers and/or strong growth, the lack of water is already noticeable for several reasons such as organic and chemical waste, illegal diversion of water (theft), application of drinking water for non-potable purposes, as well as leaks and other problems arising from pollution and distribution network (Telles 2013).

In rural areas, water contamination by chemical factors resulting from the vast use of pesticides is very common. The drought factor for example also makes intervention necessary so that the supply system does not collapse. This intervention is known as the 'caster system' and with it, it is possible to minimize the total lack of water in each period. In rural areas, the water is contaminated by chemical factors which results from the vast use of pesticides. The drought factor, for example, also makes intervention necessary. So that the supply system does not collapse, this intervention is known as the 'caster system' and with it, it is possible to minimize the total lack of water in each period. The use of water for human supply has different proportions, highlighting the fact that industrialized countries use more for personal hygiene and toilet flushing (Telles 2013). In Brazil personal hygiene and toilet flushing are also presented, but with very different proportions.

Figure 1 | Water distribution in Brazil. *Source*: ANA (2017).

3.3. Water cycle

The water cycle on our planet is also known as the hydrological cycle and water is in constant movement. This is a global phenomenon of closed circulation composed of several processes by which water starts its journey going from one stage to another, such as it is always in transition, it goes through different states (solid, liquid and gas) (de Miranda *et al.* 2010).

Both urbanization and industrialization added to deforestation strongly contribute to the change in land cover that later affects the hydrological cycle. Soil heterogeneity plus climate change also directly impact river discharges at a global level. Several hydrological phenomena need to be further studied in order to discover the present and future impact caused by these variations (Gayathri *et al.* 2015).

3.4. Brief history of the use of rainwater

Currently, the issue of rainwater use has been widespread, but the use of this water is a very old technique. As it is an essential asset for life and human development, it must always be seen as a priority in society precisely because it directly impacts the social, economic and cultural environments. History portrays that man has seeked to increase the availability of this fundamental resource for life since antiquity (Dornelles 2012).

The use of rainwater is a technique developed so that people have a greater amount of water available in a way that is more accessible to everyone. Water encompasses not only the sphere of essential resources for life, but also the social, economic and cultural sphere, given its importance. History reports that for many years man has been looking for ways to ensure that water is always available in abundance, especially in areas with less availability of this resource, such as in arid and semi-arid regions (Tomaz 2011).

It is not known for sure how old the first initiatives focused on rainwater storage are, but according to Dornelles (2012) there are records of structures developed with the same purpose dating back to 3000 BC. It reinforces the concept that this is an old technique. Tomaz (2011) mentions that in 830 BC a Moab stone was found in the region of Moab, near Israel, which already contained the King's determination that each house would need to have a cistern to store rainwater. The stone with the deed is shown in Figure 2.

4. THE COMPANY UNDERSTUDY

Regarding the company profile, it is among the three world leaders in the production of automotive and industrial bearings and has 100 years of experience. Also, the company is present and innovating in the industrial, automotive, and aerospace markets. It is a manufacturer of high precision equipment that does business all over the world in bearings and other products, also with ecological awareness that decreases energy consumption and reduces friction. Based on innovation and commitment, the company has been building its development history, designing products with high quality and technology. It currently has about 25,000 employees, located in more than 70 factories, seven R&D centers, and more than 100 commercial offices worldwide. In addition to providing services, the group designs, develops and manufactures bearings, linear guides, bearings, and automotive spare parts.

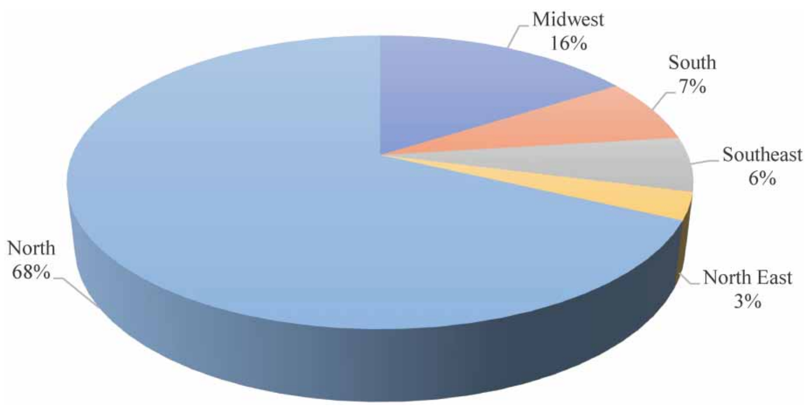

Figure 2 | Moab stone. *Source*: Cline (2009).

Figure 3 | Company areas permeable and non-permeable. *Source* – Google Maps.

4.1. Company location

The company is located in the metropolitan region of Curitiba, specifically in the industrial region of Fazenda Rio Grande. The land area is approximately 50,000 m² and it is within this perimeter that opportunities for water collection points have been identified. In general, we have an approximate area of 44% of the non-permeable area and 56% permeable area. In the figure below, it is possible to better visualize these areas (Figure 3).

In the figure above, it is possible to visualize the non-permeable area (without marking) and the permeable area highlighted in orange.

4.2. Water scenery in Curitiba and the metropolitan region

Based on the water consumption scenario of the country we can estimate that 85% is concentrated in the first three items of Table 2, with industry among the three main extractors of drinking water. It is intended to explore more closely the points of consumption and direct the research to the Fazenda Rio Grande, where the company in question is located. More specifically to the municipality of Fazenda Rio Grande, where the company in question is located. The interactive map of the national water agency (ANA) demonstrates through the qualitative and quantitative balance sheet that Curitiba and the metropolitan region are classified as 'Quali-quantitative Criticality'. This qualification is given due to the high demand (withdrawal) and a large amount of organic cargo thrown to the rivers. In Figure 4 we can note the selection of the municipality of Fazenda Rio Grande in red.

Figure 5 shows in detail the exact location of the municipality of Fazenda Rio Grande in the red area, this red area symbolizes the region that is classified as qualitative and quantitative criticality. In this way, it can be seen that the region's

Table 2 | Consumption table by point of use

	Consumption (liters)	Unit	Frequency	Day demand (m^3)
Bathrooms	12	160 Employees	3x per day	5.76
Floor cleaning	0.70	9.900 m²	1x per day	6.93
Cooling tower	330	2 Towers	1x per day	0.66
Liquid center	1.500	3 Central	1x per day	4.5
			Total m^3/day	17.85
		Total m^3/Month (24d)		428.4

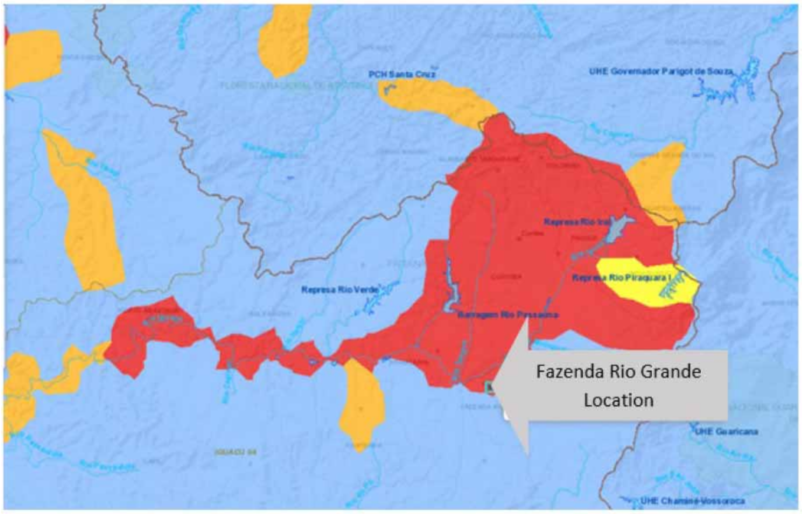

Figure 4 | Qualitative and quantitative water balance. *Source* – ANA 2020.

Figure 5 | Collection points. *Source*: Google Maps.

scenario requires alternatives to mitigate scarcity since the municipality continues to grow and soon the demand for water will also grow with this development.

4.3. Volume of water used by the company

The company currently makes all water withdrawals from the public supply network, and it does not have an artesian well and does not take advantage of rainwater. All effluent is sent to a certified company that treats liquids within current effluent treatment standards. Currently, consumption varies between 506 and 512 m^3 months, as shown in Figure 6, performed with the average for the period of 2016–2020.

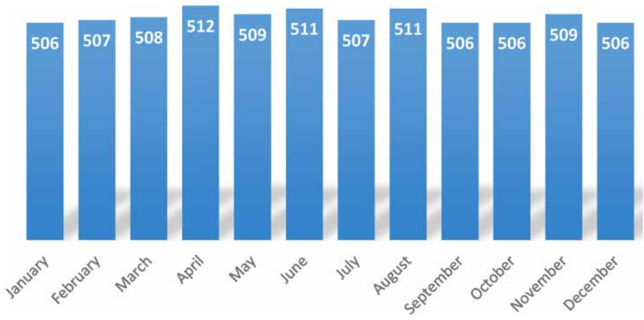

Figure 6 | Average water consumption in $m^3 \times$month (average of last four years).

According to Figure 6, even in the holiday period the volume does not have much oscillation of consumption because the teams take over and it is a favorable period for maintenance and cleaning of the factory.

4.4. Mapping the current flow of water consumption in the company

Currently, the company depends on 100% of the water supply coming from Sanepar. The analysis of the current flow of water distribution showed that the potable water network can be easily isolated for the use of rainwater for low-cost non-potable purposes, since the water extensions are distributed across sectors and are also properly identified. The current stream can be seen in Figure 7.

It is notable that potable water is used in all processes of the company including the four main points of consumption that do not require the use of potable water. Before moving to the liquid center this water receives treatment and additives specific to the process.

5. METHOD

The work methodology covered three main points: The research of scientific articles related to the subject, the verification of the company's processes and the quantification of the volumes of water consumed for non-drinking purposes and the testing with qualitative and quantitative analysis of the water collected through alternative sources. The flowchart below explains the research, which was taken over 14 months to complete and the practical part of simulation and sample testing took another 12 months. The work cycle can be seen in Figure 8.

The research was carried out using data provided by the National Water Agency (ANA) and the Sanitation Company of Paraná (Sanepar). It intends to understand more about water consumption, availability and the need to develop new forms of water collection in this region, which could be seen through dynamic maps. The research based on the platforms Capes, Scopus, Web of Science direct, SciELO, Engineering village provided several examples of rainwater collection and use.

5.1. Rainfall volume of the region

The Fazenda Rio Grande region's rainfall volume is 1406.2 mm per year. The average calculated in the period from 1977 to 2006 the data originate from the Mandirituba rainfall station (ANA code 02549062). Figure 9 presents this historical volume.

The rainfall data of the region are of great relevance because only with this information that can the volume of the cistern be calculated and allow us to better understand the scenario of the region where the company is located.

5.2. Location of collection points

For a better understanding of the points and organization of the work and field research, the points initially identified as a potential source were located on the company photo, these are identified with numerals from 1 to 4 presented in Figure 5.

The four collection points previously identified in section 3 were; (1) drainage channels, (2) ditch water, (3) climate control water, (4) shutter (convergence point of all rainwater). These points were verified by the environmental department team, where there was a consensus for their validation as potential sources of capture.

5.3. Quantification of volumes per proposed point

Through consensus on the collection points among those involved in the project, definitions were started on the method and period of monitoring of each identified potential source. At this point in the research it was necessary to effectively show the

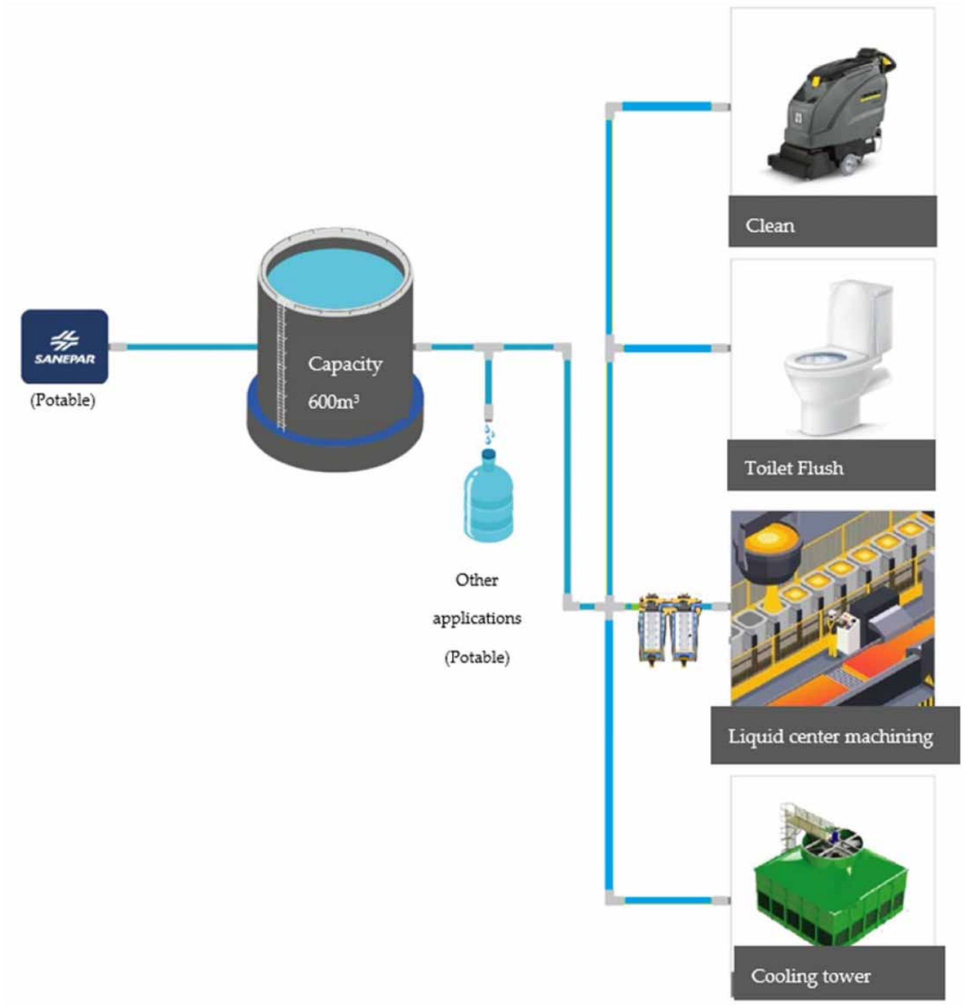

Figure 7 | Current water flow of last four years.

potential volumes of water, and as it was at that time a survey based on estimates, its volume was quantified using various techniques and equipment such as reservoir sizing simulations according to ABNT NBR 15.527, water tank installations with graduation, and/or hydrometer installations.

5.3.1. Drainage channel

Since its conception, the drainage channel had the sole purpose of directing water to the park behind the company, avoiding flooding of the neighboring company in case of torrential rain, it became a rainwater catchment point. For the validation of this point, a DJI Air 2S model drone was used, together with the DroneDeploy® application to obtain a specific manual flight plan for carrying out topography but as it is a new model of drone, the software does not support fully autonomous flight. The topography reveals the position of the current channel favors the capture of water and also allows us to apply a 100 m^3 reservoir for water storage that will be directed by gravity without the need to install pumps to pressurize water from the channel to the cistern. In detail, the green dot in the figure below shows the location of this reservoir (Figure 5).

5.3.2. Industrial air conditioner water

After a year of monitoring the volume of water generated by the condensation process, it demonstrated a great variation due to the various conditions of temperature and humidity. Also, the factory activity itself demands more or less heat exchange contributing or not to the increase in the volume of condensate. For this stage, a 3 m^3 water tank was installed and a hydrometer was installed at the outlet where the average daily volume measured was 1.5 m^3. The condensed water has a high quality

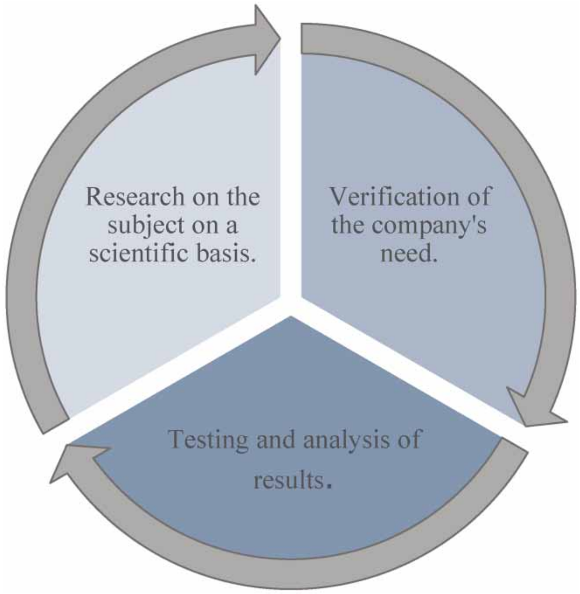

Figure 8 | Stages of work.

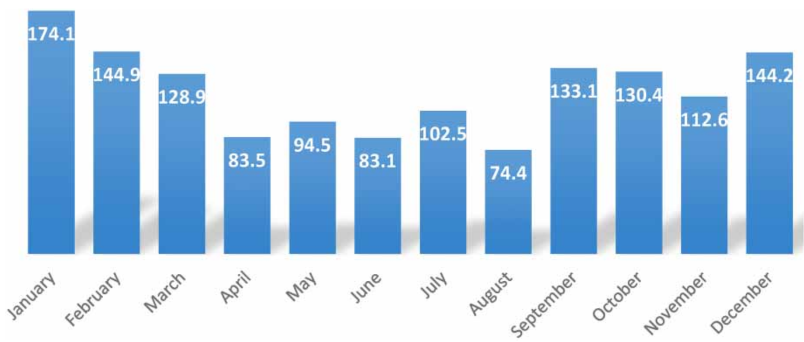

Figure 9 | Average monthly precipitation from 1977 to 2006. *Source*: Atlas pluviometric do brasil (Pinto 2011).

for use in non-potable purposes. So, some or no treatment is required before its use, in this case the analysis proved the security of the application. The water went directly to the liquid plant 'water and oil' and the surplus went to the shutter.

5.3.3. Drainage moat

The water from the drainage pit is pumped into the rainwater net, as it has good quality water feature for non-potable purposes. So, it is going to be directed to the shutter to be pumped into the rainwater reservoir. For better measurement a hydrometer was also installed in the outlet pipe, thus allowing better monitoring of its flow. The average volume measured was 3.07 m^3 day.

5.4. Sample collection and analysis

The collection and analysis of water are the main points of the work, since the quality of this water will enable its use not only in bathrooms and cleaning, but also in the production process. The treatment of water is also very relevant because, even when groomed, employees have spend long periods at the company during their working hours.

5.4.1. Water collection

The collection of water was carried out using two bottles as directed by the laboratory. An extra 100 mL sample was collected in a sterile flask. The laboratory's recommendation is that the samples be collected and kept cool during transport, and the analysis should be done within 24 hours after collection. In Figure 10 it is possible to observe the samples packed in a thermal bag, and around them ice sheets in gel.

The samples were taken a few hours after collection and analysed. The time to return the result is around 7 days as the DBO test already requires 5 days, in short, DBO corresponds to the necessary amount of oxygen so that, under aerobic conditions, there is oxidation of the biodegradable organic matter.

5.4.2. Water analysis results

Due to the convergence point of rainwater from the drainage pit, water from non-permeable areas, asphalt sidewalks and rooves, the analyses and monitoring of water quality were removed from this part of the work. During the collection step, which occurred after discarding, the volume retained in the shutter was approximately 100 m^3 after the rain started. So, the result of the analysis demonstrates a need for more intensive water treatment. All the results can be seen in Table 2. Thus, it was possible to evaluate the water quality more assertively without having to isolate the sources of dosage later to treat the waters. Differently, if the result of the analysis demonstrated a need for more intensive water treatment, the results of the analysis can be seen in Table 3.

Observations:

1. The results presented in this report are limited to the sample received by LabQi – Environmental Analysis Laboratory.
2. The methods used in the assay are based on the methodology presented by APHA – Standard Methods for the Examination of Water and Wastewater, 22nd edition, 2012.
3. ND=Not Detected

The results presented in the test show that the use of this water is safe as long as it is properly stored and treated following the Brazilian normative NBR 15527/2019.

5.5. Lifting of consumption per point (non-potable)

Through the research carried out throughout the work it was possible to determine the volumes of water consumption for non-potable purposes. The volume raised is described in Table 2.

With the data in the table it is evident that 84% of the monthly water consumed is used for non-drinking purposes. During this stage, the biggest challenge seemed to be the installation of water meters and it is clear that monthly monitoring requires a reasonable time given the distance between the measuring points.

Figure 10 | Sample packaging.

Table 3 | Analysis results of water from the shutter

Parameter	Analytic result	Quantified limit	Detection limit	Methodology
Total coliforms	Present at 100 mL	–	–	9223 B
Escherichia coli	Present at 100 mL	–	–	9223 B
ph	8.01	0.1	0.01	4500-H B
Turbidity	7th uT	1	0.5	2130 B
Electrical conductivity	25.94 μS/cm	0.1	0.01	2510 B
Total dissolved solids	17 mg/L	1	0.1	2540
Total suspended solids	ND	5	1	2540
Total solids	17 mg/L	1	0.1	2540
Total hardness	8.1 mg/L	0.1	0.01	2340 C
COD	ND	10	3	5220 D
DBO	ND	10	5	5210 B

5.6. Sizing of the water tank

Regarding the reservoir sizing, the Brazilian normative NBR15527 – 2007 (ABNT 2007) was used as the basis for the sizing. This standard deals with the requirements of the use of urban cover waters for non-potable purposes and also presents six methods of sizing water reservoirs. When evaluating the results of the methods tested, the Neto Azevedo method (Equation (1)) was chosen for having returned a result closer to the reality of the company. The simulation method was also used and validated the results since the collection potential was higher than the company's demand. So, unfortunately, the methods presented in Brazilian normative NBR15527 did not converge with each other, so they were not equivalent. Note that, a specific formula does not exist to calculate the period of some particular spots of rain, which were considered the rainy months below 100 mm, in this case four months (April, May, June, and August). So, these months are considered as a month of drought and/or little rain. Thus, the volume of rain is obtained by the following equation:

$$V = 0.042 \times P \times A \times T \tag{1}$$

where P is the numerical value of the average annual precipitation (mm); A is the numerical value of the collection area in projection (m^2); T is the value of the number of months of little rain or drought (month or months); V is the numerical value of the usable water volume and the water volume of the reservoir (L); and 0.042 is the standard loss coefficient used by the Azevedo Neto method.

The data for the application of the Azevedo Neto method and simulation are listed below in Table 4. The rain data is provided by the Brazilian Pluviometric Atlas (Pinto 2011).

To calculate the dimension of the reservoir, the rainfall data from the period 1977 to 2006 were used. Table 5 lists the average volume per month within this period and the volume is presented in mm.

Table 4 | Tank calculation information

General information	
Collection area (not permeable) *Roof and asphalt area.	20327st sqm
Rainfall Index (annual)	1406.2 mm
Daily demand	16.93 m^3
Month demand	508 m^3
Non-potable end water	352 m^3

Table 5 | Rainfall volume (period 1977–2006)

Acquisition period 1977 to 2006	
Month	**Average volume in mm**
January	174.1
February	144.9
March	128.9
April	83.5
May	94.5
June	83.1
July	102.5
August	74.4
September	133.1
October	130.4
November	112.6
December	144.2

By applying the equation with the data in Tables 4 and 5 we have (Equation (2));

$$V = 0.042 \times P \times A \times T \tag{2}$$

$$V = 0.042 \times 117.18 \times 20,327 \times 4$$

$$V = 400,162.20 \text{ L or } 400.16 \text{ m}^3.$$

The data in Tables 4 and 5 were used perform the simulation method, and the results can be seen in Table 6 below:

Table 6 | Simulation method

Tank Simulation Analysis

Runoff coefficient (CR) =	**0,8**								
Reservoir volume (m^3) =	**600**								
Months	**Monthly average rain (mm)**	**Monthly demand (m^3)**	**Catchment área (m²)**	**Monthly rain volume (m^3)**	**Volume of the fixed reservoir (m^3)**	**Reservoir volume in time (t−1) (m^3)**	**Reservoir volume in time (t) (m^3)**	**Overflow (m^3)**	**External water supply (m^3)**
January	225.8	428	20,327	3672	600	0	600	2644	0
February	186.6	428	20,327	3034	600	600	600	2606	0
March	69.2	428	20,327	1125	600	600	600	697	0
April	100	428	20,327	1626	600	600	600	1198	0
May	106.2	428	20,327	1727	600	600	600	1299	0
June	25.6	428	20,327	416	600	600	588	0	0
July	41.6	428	20,327	676	600	588	600	236	0
August	104.2	428	20,327	1694	600	600	600	1266	0
September	179.2	428	20,327	2914	600	600	600	2486	0
October	116.6	428	20,327	1896	600	600	600	1468	0
November	170.4	428	20,327	2771	600	600	600	2343	0
December	162.1	428	20,327	2636	600	600	600	2208	0
Total	1487.5	5136		24,187				18,451	**0**

When we evaluate the numbers presented in this method, it is possible to identify that there is no need to supply water from the public supply network. Even in the lower rain month, in the case of June, the reservoir will be connected to the public network. This is because where there is some contamination or atypical period of drought it will need to receive water from the public network. After all, the pipe of the toilets, external cleaning taps, and alpine tower will be connected directly to this reservoir, no longer to the potable water tank.

5.7. Proposal of the new flow of distribution

To define the new water distribution flow, it was necessary to first evaluate the volume of capture in power and also to analyze the chemical-physical characteristics of the collected samples. With the results in hand and according to the guidelines of the Curitiba Law (Law10,785 of September 18, 2003), the municipal law of Fazenda Rio Grande (Law No. 1.365/2020 DE 27 January 2020), it was possible to define the new flow according to Figure 11 that contains in detail the identifications of 'A' to 'E' for a better understanding of the functioning (see Figure 12).

Based on quantitative and qualitative data raised, the new distribution flow provides the transformation of the current reservoir of drinking water with a capacity of 600 m^3 (detail 'E') into a reservoir for non-potable water storage. The water coming from the conditioner is stored in a reservoir with a capacity of 3 m^3 (detail 'B'). The drainage pit and rain were damned on the shutter (detail 'C'), also recounting the reservoir of the drainage chute with a capacity of 100 m^3 (detail 'D'). The treatment will be carried out with particulate and chlorine filters according to the Brazilian normative NBR 15527/2007. The current hydraulic internal distribution network greatly favors this transformation. The points of water potable scans are very close and located only in one region of the shed, which means it is very easy to dismember from the new network of water non-potable. The drinking water machine can double its capacity if compared to the consumption of the month, which means it is pre-visa the acquisition of a new reservoir with a capacity of 200 m^3 (detail 'A') exclusive to water drinking water, this reservoir may complement the non drinkable water in face of some scenario of long periods of drought. Even in that period, the system will still have the capture of the water from the conditioner and the drainage gap that rotates around 4.5 m^3 per day.

6. CONCLUSIONS

The main objective of the work was achieved because the results of the analysis carried out during the research have enabled the design of a new flow for the collection and distribution of non-drinking water. Thus, the consumption reducing of drinking water

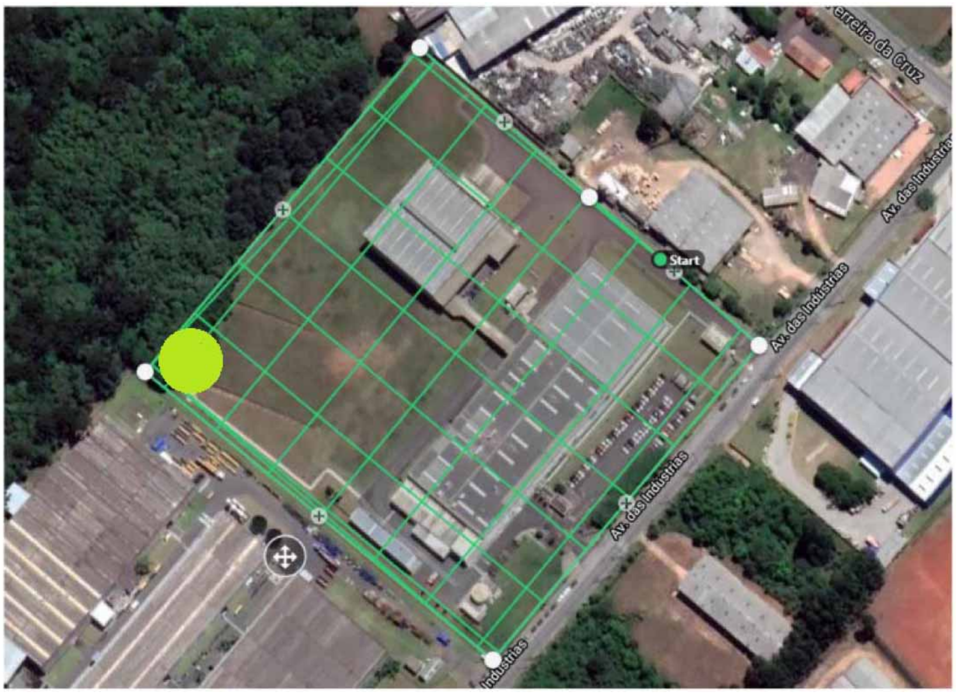

Figure 11 | Flight plan on dronedeploy®. *Source*: Google Maps.

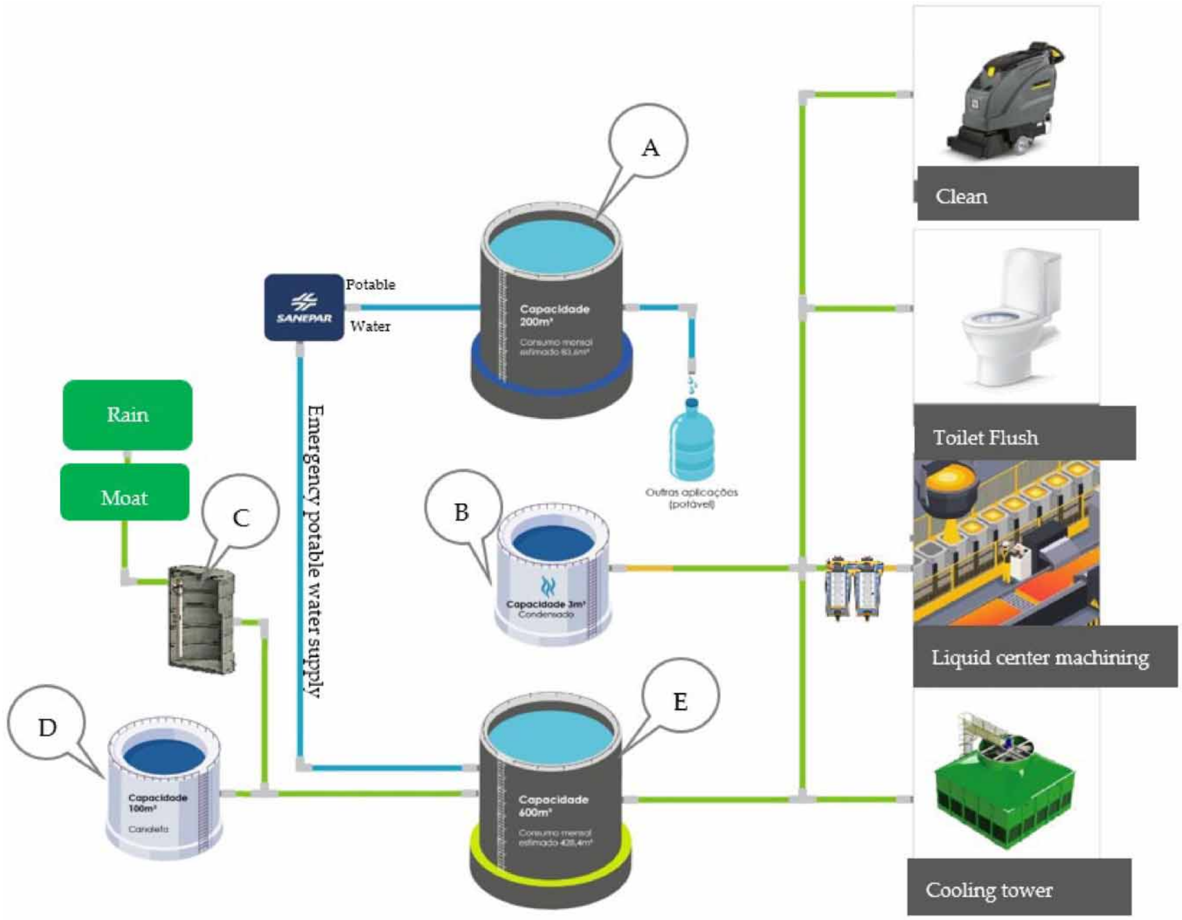

Figure 12 | New storage and distribution flow.

by up to 84% is a much higher volume the proposed by the group, which is 30%, even with the potential to replace 100% of the water demand. So, 16% of drinking water is intended for human consumption, which required a broad and normative study, also a specific treatment for potabilization. So, this work did not lead to this volume destined for human consumption in order for it to remain as a recommendation for future work. Currently, we are still using water from the ditch and the climate control system for general cleaning, and these two sources alone provide around 133 m^3, equivalent to 26% of the current volume consumed by the company, and only 4% below the volume. The reduction proposed by the group in the company, as a manual supply and with an adapted distribution, seems to be not possible to make an integral and systemic use of this volume.

Through the interactive maps of the national water agency (ANA) it was possible to conclude that the condition of Curitiba and the metropolitan region requires new sources of water collection to avoid greater rationing, which now takes place on some weekends throughout the year. The conditions of the current hydrographic basins do not keep up with this growth in the region, both residential and industrial, therefore, based on this evidence, the work went from just a vision of the group in the environmental issue to a vital need for the company's operation in the midst of this scenario of water scarcity.

Even knowing that there are some challenges for these captures, including the technical part, as we do not have control over the climate, we can have a large volume of precipitation in a small period of time where the accumulation of 100 m^3 provided by the shutter may not be fully utilized depending on the pumping capacity, to minimize this loss of volume. So, the dammed water in the reservoir of the drainage channels was added to the water from the ditch and climate control, and it will contribute to the composition of the non-potable volume.

The convergence of facts and data studied, together with the environmental visions of large business groups, validates the global concern of public and private entities related to the conservation, preservation and conscientious use of this vital resource for human survival on Earth.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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