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Analyze Condensed Water Quality: A Case Study in a Public Building

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***Keywords*— Condensed water collection, Socio-environmental practices, Water resources, Pernambuco Court of Justice.**

***Abstract*— *The reuse of water from air conditioners has proved to be a valuable alternative to the water waste promoted by the excessive use of drinking water in activities that would not necessarily require clean water, such as washing external areas and windows. In this sense, the general objective of the present work is based on evaluating the thematic pertinence of the adequacy of the network implementation for the reuse of water from the dripping of the Forum Lourenço José Ribeiro (Fórum de Olinda) air conditioners, an organ that is part of the Tribunal of Justice of Pernambuco, located in the city of Olinda/PE. The case study is shown as a sufficient methodological apparatus to obtain results, which were evaluated through qualitative and quantitative techniques, intending to achieve a correct understanding of the cost savings with the implementation of drip water treatment of air conditioners in this building that is part of the Pernambuco Court of Justice. Results obtained indicate that the alkalinity of the water from the air condensers could not be used for human consumption, but it is suitable for use in non-noble purposes, such as washing the Forum patios. With this, the reuse of water resources resulting from the dripping of air conditioners is efficient to promote the yield of a natural asset that needs to be used within its maximum capacity, through the appropriate treatment that allows the reuse of the hydric matrix.*

I. INTRODUCTION

The imminence of the Earth's most precious natural resource impoverishment puts society in a position to seek efficient alternatives for maximum use of what is available for human use. In this perspective, there are studies that seek the reuse of potable or non-potable water that were discarded in residential, industrial, business and agricultural environments. According to Sousa *et al.* (2021), the reuse of water, as well as its use, as they are reputable and reliable procedures, have been established as one of the most beneficial alternatives for saving water.

Among the water resources commonly discarded, the reuse of condensed water from the dripping of air conditioners could guarantee the reduction of a certain use of drinking water and contribute to the sustainability that has been revealing itself as the great promoter of the balance between the environment and humanity (CORDEIRO, 2019).

Taking into account the immense human population and the scarce percentage of fresh water available in the world – in addition to countless other examples that indicate the increasing decrease of natural resources available in nature – human society needs to adapt its needs to the awareness of ecological finitude, especially in the concerning water resources. In this vein, Silva and Santos (2019) add that the uncontrolled use, the scarcity of rain and pollution bring a reflection on the sustainable use of water.

The different purposes and use of water resources are not at the same level of social and human relevance. In this sense, there are purposes considered noble, such as drinking water for human consumption, and purposes called non-noble, where the use of water is not intended for people, but for washing, toilets and landscaping (such as and water features).

Therefore, it is possible to scale the applications of this water resource and ensure that its reuse saves potable springs from being used in services that could easily be supplied by non-noble sources. Carvalho *et al* (2016) explains that reuse of water from air conditioners needs to undergo a qualitative assessment of the water, where physical-chemical standards (such as pH, alkalinity and hardness) are analyzed and compared with parameters established by the Ministry of Health, to find out if it is possible to reuse this water in a safe and healthy way.

As of the different uses of water, it is imperative to reflect on the application of water resources and the likely reuse of this in the so-called non-noble purposes. This reflection dialogues with the principles of sustainable development, as water is a natural resource that is on the verge of scarcity and demands solutions and technologies capable of increasing its chance of use and reuse.

Over the years, in favor of the rational use of water, the need arises to rethink the ways of using water resources, adopting sustainable practices that aim to guarantee the future of the new generations. The ways to mitigate the impacts can be the reuse and use of water, which includes the use of water from air conditioning devices (SOARES, SOUZA JÚNIOR and SILVA, 2021, p.1).

In the support of the public example that has been preached in recent years, the State has become the main example of acting with socio-environmental responsibility, so that it is pertinent to verify the feasibility of using the condensed water produced by air conditioners in buildings where the activities of the Court of Justice of Pernambuco are carried out. Even in public buildings that have subsidized water costs and that do not have large expenses with the purchase of drinking water, the incorporation of environmental sustainability criteria is of great value (CARDOSO, 2018, p.90).

As the Pernambuco Court of Justice is a component body of the Brazilian public administration, it is committed to promoting sustainability at the entire scale of its activity by virtue of the legislative provisions and resolutions formulated by the National Council of Justice (CNJ), in order to promote sustainability practices (CORDEIRO, 2015).

The present study aimed to evaluate the relevance and suitability of implementing a network for the use of wastewater from the dripping air conditioners of the Forum Lourenço José Ribeiro (Forum de Olinda - building that is part of the structure and competence of the Court of Justice of Pernambuco).

II. BIBLIOGRAPHIC REVIEW

The motivations for the search for solutions and alternatives that may reduce water stress are evidently important. Even if renewable, quality and potable water resources are scarce. As an alternative, reuse can help reduce the use of potable water for activities that do not require potability (MOURA *et al*., 2020, p.791).

The water used for human consumption and for socio-economic activities is taken from rivers, lakes, dams and aquifers, also known as inland waters. The development of cities without proper environmental planning results in significant damage to society. One of the consequences of urban growth was the increase in domestic and industrial pollution, creating inadequate environmental conditions and favoring the development of diseases, air and noise pollution, temperature increase, groundwater contamination, among other problems. Brazilian urban development is concentrated in metropolitan regions, in the state capital and in regional hub cities. The effects of this reality are felt on all urban equipment related to water resources, water supply, transport and treatment of sewage and rainwater. The development and growth of cities generates an increase in domestic and industrial pollution, leading to an increase in sediments and solid material, as well as contamination of springs and groundwater. (CETSB/SP, 2020).

Population growth, responsible for the growing demand for drinking water, linked to pollution and the non-rational use of water, results in a scenario of water scarcity in certain regions of all continents, especially in regions with low rainfall. Seeking to reduce the consumption of drinking water for less noble purposes, reduce the pressure on water reservoirs and combat water scarcity, the concept of rational use of water emerges. Based on the principles of minimization, separation and reuse, this concept brings the suggestion of using alternative sources of water, one of which is condensed water from the operation of air conditioners. Such devices work in such a way that water condensation occurs, and this effluent, for the most part, is discarded. (MARINHO, ATHAYDE JÚNIOR and QUARESMA, 2021, p.1)

2.1 The environmental crisis and the new demands for water efficiency

Human existence has its continuity associated with the need to preserve available sustainable natural resources. These resources represent everyone’s right, being indispensable for the preservation and continuity of the human species itself. In view of this, it is urgent that groups structured in cities and communities pay attention to the needs of future generations. These needs are increasingly linked to environmental issues, essential to human life. (GOULART and PIETRAFESA, 2019, p.734)

The large-volume production of consumer items began to generate demands and, as a result, the extraction of natural resources was intensified. Even agriculture, which was once intended for subsistence, became large-scale, with crops for sale in various markets around the world. Currently, this model of consumption, production, and unbridled natural extraction threatens not only nature, but its very existence. We can see the depletion of essential resources for the various human activities and the extinction of animals that were once abundant on the planet. For these reasons it is necessary for human beings to adopt a more sustainable posture. (RODRIGUES *et al.*, 2019, p.4).

In terms of water, Brazil is a rich country, which allows wide availability of water resources, with 13.7% of all freshwater available on the planet, and shelters enormous water biodiversity in the Pantanal region, considered the largest continental wetland in the world, and the Amazonian floodplain, the most extensive flooded forest on Earth. However, although privileged in terms of quantity and quality of water, these resources have been used irresponsibly. Overexploitation, lack of concern for water sources, poor distribution, pollution, deforestation and waste demonstrate the lack of care for this valuable asset. Misuse endangers the lives of all living beings. (CAPELLARI and CAPELLARI, 2018, p.3).

The contemporary discussion about the water crisis goes beyond the simple finitude of drinking water, encompassing the failures of public policies, based on economic models that prioritize immediacy. These policies are based on monetary parameters rather than the conscious use of resources, compromising biodiversity and the balance of ecosystems. With the disruption and imbalance of natural habitats, pollution, contamination and scarcity of water were inevitable, forcing human beings to rethink their relationship with nature. Although the problem of capturing and distributing water has worsened mainly in urban centers, in rural areas it has been pronounced in the face of agribusiness policy and its political, economic and industrial dominance over the land (FISCHER *et al.*, 2021, p.226).

Currently, the world population grows by an average of 0.9% per year, and will reach 9.7 billion people in 2050. Such growth results in an increase in the demand for water resources, which, because they are finite, can generate a supply crisis on a global scale, imposing permanent water rationing on society. (MARINHO, ATHAYDE JÚNIOR and QUARESMA, 2021, p.1)

Water scarcity is already a problem faced by many countries in the world, since some factors have caused the reduction of its quality and distribution, such as: disorderly development of cities, pollution, poor management of water resources and high population and industrial growth. These factors generate an increase in the demand for water, which can cause the depletion of this resource. (SIMES *et al.*, 2020, p.181)

In Brazil, the water crisis has been affecting the population of several states, with water rationing for human supply, reduction of available water for irrigation, animal watering, among other problems. (FERREIRA and TOSE, 2016, p.182)

So that this natural resource does not run out and that there is no damage to the quality of the world's reserves currently available, it is essential that water is not wasted, polluted or poisoned and its use must be carried out consciously. Data on water consumption is provided by the United Nations: worldwide, agriculture accounts for 70% of all water consumption, compared to 20% for industry and 10% for domestic use. In industrialized countries, however, industries consume more than half of the water available for human use. (CAPELLARI and CAPELLARI, 2018, p.2)

Water scarcity can occur in two ways: by quantity, normally caused by natural causes, such as prolonged regional droughts; and by quality, generally caused by human action, such as pollution processes triggered by the release of urban and industrial effluents into surface waters, intensification of individual consumption, waste in public and building systems due to leaks and inadequate procedures related to the water usage. (SIMES *et al.*, 2020, p.181)

Expectations regarding the availability of water in the coming years only decrease. The scarcity of drinking water will affect more than half of the world's population in up to 50 years, due to current global trends, such as deforestation, population increase, urban growth, among others. This situation occurs due to pollution of water sources, misuse of natural resources, deforestation, planet climate change, disorderly population growth, increasing consumption, waste, lack of public policies that encourage sustainable use, in addition to irregular distribution. (FERREIRA and ALVES, 2018, p.9)

According to Law 9,433/97, which establishes the National Water Resources Policy (PNRS), water is a public domain good, a limited natural resource, with economic value, which is why the management of water resources must always provide the multiple use of water. (SILVA and PINTO, 2019, p.4)

Sustainable development is the means capable of meeting the needs of the current generation, ensuring the ability to meet the needs of future generations. The rational use of water can be defined as the practices, techniques and technologies that improve the efficiency of its use, and the search for efficient processes for the reuse of water has been highlighted in recent years. (FERREIRA and ALVES, 2018, p.9)

The measures announced to face the water crisis bring the recommendation that the Public Power adapts, as a matter of urgency, its governmental codes of posture with a view to restricting activities notably recognized as promoting water waste, such as the use of hoses for washing automobiles, sidewalks, facades, floors, walls and windows; irrigation of gardens and lawns; roof cooling; washing of streets and avenues, unless the source is water from reuse or another recovery technique. (FERREIRA and TOSE, 2016, p.182)

Access to safe drinking water and sanitation is an essential human right for the full enjoyment of life, and is intrinsically linked to the rights to life, health, food and housing. In Brazil, urban water supply is experienced differently by different social strata. Although the common citizen is not aware, Brazilian legislation, at the federal level, has the Resolution of the National Water Resources Council that provides guidelines, criteria and modalities for reusing water. The modalities are: reuse for urban purposes, reuse for agricultural and forestry purposes, reuse for environmental purposes (recovery of degraded areas), reuse for industrial purposes and reuse in aquaculture. (SILVA and PINTO, 2019, p.1)

Water is a commodity widely used by everyone and is irreplaceable, for this reason it is necessary to develop skills, knowledge and procedures for the rational use of water, acting in the conservation of this resource so necessary for the existence of all. The term water conservation means the controlled and efficient use of the resource and, in this way, contemplating both rational use and reuse. (ORTIZ *et al.*, 2021, p.25135)

The general perception, still common among populations, is that fresh and renewable water is an infinite resource. However, it is known that it is indispensable to life, renewable, but relatively scarce and, in many regions of our planet, it is possible to observe the decreasing supply of water in terms of quantity and/or quality, being able to cite as main factors the poor distribution and changes in the hydrological regime that lead to reduced rainfall and aquifer recharge; and the increase in demand, resulting from the accelerated growth of the population, the expansion of productive activities such as agriculture and industry, whether for grain production or economic growth. Its waste and inappropriate use such as pollution and degradation of water sources can also contribute to the decrease or, in the not too distant future, to deplete this resource. (SOUSA *et al.*, 2016, p.37-38)

The main factors that may affect the availability of water resources are population growth, economic growth, changes in production and consumption patterns and increased demand for water, both for domestic, industrial and agricultural purposes. To change this scenario, it is necessary to use sustainable policies and measures that promote the rational use of water. (MARINHO, ATHAYDE JÚNIOR and QUARESMA, 2021, p.2)

Except for a few exceptions motivated by the individuality of water use in some regions, actions that maintain the quantity and quality of water use are of great importance in large urban centers, because as the level of water availability increases, so does the level of economic development in the region, considering that countries that have a stabilized government management seek to meet their water demands while preserving the quantity and quality of the water used. (SILVA, 2018, p.15)

Environmental catastrophes, such as the collapse of mining dams, also highlights the dependence that living beings have on water resources. Water is essential in the most diverse spheres, passing through economic, social and cultural resources, to the right to a dignified life. There is a fragility of environmental laws in Brazil that creates social disparities and the unequal distribution of environmental risks, causing environmental injustice. (MORAIS *et al.*, 2021, p.143)

Water, as a natural resource, needs to be used fairly and coherently, so that there is a balance between the availability of this resource and its demand, thus reducing conflicts over its use. Water must be understood as a legal, economic and social asset, it is a limited natural resource, in the public domain and endowed with economic value, which requires proper management. (CAPELLARI and CAPELLARI, 2018, p.10)

Humanity needs to build new ethical values placing water as an indispensable good for life, a fundamental human right, ensuring a healthy environment for all species and guaranteeing the sustainability of the planet. The ethical use of water demands moral conditions that enable global health and mitigate environmental, moral and health vulnerabilities with the collective awakening to social, environmental and individual injustices (FISCHER *et al.*, 2021, p.227).

2.2 Condensed water reuse

The importance of alternatives for the reuse of water, for non-potable purposes, in order to avoid its waste, is based on the principles of sustainability. (FERREIRA and ALVES, 2018, p.7)

It is necessary and essential to implement alternatives in the reuse of water, in addition to the search for viable technologies of use, given the problem of water scarcity in numerous areas around the world. (SILVA and PINTO, 2019, p.2)

The focus of water for people's daily lives ranges from direct to indirect consumption; since there are several ways in which water is being used, it can facilitate and guarantee human life, and ensure that some needs are met, without the depletion of this resource. According to this context, it is interesting to create measures to minimize the waste of water, and consequently its reuse or reuse, since the effectiveness in this task brings more positive effects than any other water use policy, thus attesting to its sustainable use. (GOMES *et al.*, 2018, p.1)

In this sense, the water from condensation in air conditioners stands out for its high potential for use, and can be used for washing floors and watering plants and even other nobler uses. The amount of water produced by the air conditioner depends on the brand, power and climatic conditions of the place. (MARINHO, ATHAYDE JÚNIOR and QUARESMA, 2021, p.3)

Air conditioners suck the air existing in a given environment, which, when passing through the evaporator coil, suffers a drop or increase in temperature due to contact with the coil. The air is then returned to the environment at a hot or cold temperature, depending on the user's need. When there is a variation in temperature, the sensor activates the compressor again, responsible for circulating the refrigerant gas. When traveling through the evaporator coil, the air undergoes a change in temperature and thermal exchange occurs. Finally, the distilled water that has been condensed is directly directed to the device's drainage system. (NASCIMENTO *et al.*, 2019, p.137)

The water released from the air conditioning units comes from the air conditioning drains, that is caused due to its condensation process and it has a random destination, thus generating a great water waste. This waste is caused by consequences that can affect both the users of the devices and the place itself. Among these consequences is the accumulation of water puddles, which can lead to possible breeding foci of the dengue mosquito. (FERREIRA and ALVES, 2018, p.21)

Air conditioners are classified according to their use - which can be residential, automotive, commercial, hospital or industrial - and as to their capacity - small, medium or large - which will depend on the appliance's cooling power, which is supplied in BTU (British Thermal Unit). In the case of machine technologies, these can be conventional or inverter, which is developed aiming to minimize the cost of energy during its operation. In addition, the appliances are classified according to the type of system, whether it is direct expansion – operating with the direct use of a refrigerant gas to cool the air to be conditioned – or indirect – using the secondary refrigerant, which is cold water. Common, small-scale residential and commercial appliance types are: window, hi-wall, cassette, floor-to-ceiling and ducted; they vary in terms of installation method, formats and cooling power. While large commercial appliances are known as fan-coils and have the following lines: hi-wall, cassette, console (similar to the flooring) and the duct (built-in). These are found with a capacity, in BTU, greater than the small ones. (CALDAS;CAMBOIM, 2017, p.176)

It is necessary to search for strategic techniques for water reuse, through changes in the habits of the whole society, for the sustainable use of this resource, aiming to reduce the demand on springs. The Air-Conditioning appliances, when in operation, produce water by dripping through the drainage pipe, derived from the moisture in the air, condensed by the appliance when it cools the air in the internal environment. This water in most cases is not used, considering the large-scale use of air conditioners in commercial and residential buildings, the volume that drips is significant. (FERREIRA and TOSE, 2016, p.182)

Air conditioners promote the generation of water resulting from condensation, which most of the time is wasted to the ground or to the sewer. This way, the use of this water depends on the efficient collection of each drainage system of the devices that can be directed to a collection and storage system. (FERREIRA; ALVES, 2018, p.22)

One of the alternatives for the use or reuse of water is the use of condensed water in air conditioning systems, which are widely used in commercial and residential buildings. Air conditioning is defined as the process of conditioning the air aiming at controlling its temperature, humidity, purity and distribution in order to provide comfort to the occupants of the conditioned room. (SILVA and PINTO, 2019, p.1)

Water reuse is understood as a technology developed to a lesser or greater degree, depending on the purposes for which the water is intended and how it has previously been used. Air conditioners are used on a large scale, from public buildings (schools, public agencies, etc.) to residential buildings. The use of these devices generates water dripping, derived from the humidity in the air, condensed by the device when it cools the air in the internal environment. The air conditioners, when in use, remove the existing humidity in the place where they are installed and carry out the condensation. The existing drains in this device, in turn, release the water produced by the equipment, which in most cases is wasted, when it could be reused for other purposes, and also generates constructive pathologies in buildings that cause physical and aesthetic damage to the building. (NASCIMENTO and VIEIRA, 2021, p.2)

There is an urgent need to implement constructive and efficient programs that allow for the rational use of water with the consequent conservation of water resources, acting with sustainability. It is important to highlight that some of the factors that greatly contribute to the worsening of this situation are excessive human consumption, pollution and waste. (MORAIS *et al.*, 2021, p.144)

Water from air conditioning is an example of a simple, sustainable alternative to reduce waste. Despite the variety of devices, the operating principle for refrigeration follows the same pattern, in which the evaporation of a refrigerant fluid is used to provide refrigeration. This volume of condensed water from the air conditioners can be used for so-called non-potable uses, such as watering the garden, and general cleaning (washing floors, cars, etc.). (VIEIRA *et al.*, 2021, p.366)

“Less noble” waters should be used for “less noble” purposes. And, given that the water crisis was classified by the World Economic Forum as one of the greatest global risks (WEF, 2016), actions aimed at conservation and sustainability in the use of water resources are of fundamental importance. (PRADO, SOARES and SILVA, 2021, p.2)

It is known that air conditioners perform condensation when they remove moisture from the air, generating a certain amount of water that is released through the drain and goes to the ground or sewer. The reuse of water from devices that release a certain flow contributes significantly to the rational use of potable water. Thus, collection projects in buildings that use drinking water in large proportion, add up to a productive and effective portion in the general aspect. (CAMPOS *et al.*, 2019, p.59)

It is essential that, for future constructions, a system for the reuse of water coming from air conditioning devices must be included in the project, aiming at a good economic and environmental performance of the buildings. Reusing water provides benefits because it reduces its demand, in addition to preserving the environment, saving energy, reducing investments in infrastructure and enabling the improvement of industrial processes. (CAMPOS *et al.*, 2019, p.67)

The permanent management of water demand in buildings, especially in urban centers in regions with water vulnerability, is an emergency issue in Brazil, regardless of possible lack of rain at a given time or region (CÁCERES, 2018 p.27).

In buildings where there are large amounts of high power appliances, the production of condensed water becomes relevant. (SOARES, SOUZA JÚNIOR and SILVA, 2021, p.3)

In the midst of an increasing unavailability of drinking water on planet Earth, it is necessary to take mitigating measures so that this scenario begins to change. Given this, measures such as water reuse are a solution to achieve this goal, above all, in the name of environmental sustainability. (SIMES *et al.*, 2020, p.192)

III. METHODOLOGY

In search for the scientific rigor of the present research, the case study is shown as a sufficient methodological apparatus to obtain results. These will be evaluated through qualitative and quantitative techniques, with a view to achieving a correct understanding of the possible savings in expenses with the implementation of the collection and reuse of condensed water from the air conditioning units installed in the Forum Lourenço José Ribeiro building, an integral building the structure and jurisdictional powers of the Pernambuco Court of Justice.

The present work was initially built through a bibliographic, legislative and documentary survey that aimed to understand the state of the art on the reuse of condensed water and the possibility of applying this tool in a public building that is part of the jurisdiction of the Pernambuco Judiciary.

The bibliographic survey carried out now comprises especially the production of scientific articles published in electronic journals in recent years (as a rule, in the time frame between 2016 and 2021) that address the reuse of condensed water, as well as the socio-environmental responsibility of the Judiciary as a component of public administration and information structure about the water crisis in the world, which demands the creation of solutions and technologies for reuse and maximum savings of water resources.

Among the documentary contributions, the reports produced by the Court of Justice of Pernambuco and by the National Council of Justice regarding the monitoring of socio-environmental practices that have been encouraged in the Brazilian Judiciary were relevant. The relevance of the data and graphs extracted from the TJPE Sustainable Logistics Plan (base year 2021) and from Resolutions n. 201 and 400 of the CNJ, which guide environmentally appropriate actions for all component bodies of the Brazilian justice sphere.

Among the references extracted from the United Nations, the documents on the Millennium Development Goals (SDGs), Agenda 21 and A3P were relevant, being in all cases the focus on environmental goals that must be implemented by the Brazilian public administration.

The methodology used sought the bibliographic, legislative and documentary contribution to understand the subject and integrated the theoretical knowledge with the collection and laboratory analysis of the water quality produced by the dripping of the Lourenço José Ribeiro Forum (Olinda Forum) air conditioners, in order to understand the potential of its use in activities specific to the public building in question.

The research in question has an exploratory nature and is anchored in a quali-quantitative approach.

For this purpose, Test Report No. 187,353, prepared by the Laboratory of Analytical Chemistry - LQA/ITEP, was used.

The Olinda Forum has 293 VRF System type air conditioners, and the research aimed at the physical-chemical analysis of 01 (one) sample (code 29840) of water expelled from the air conditioner (VRF System type) of the Vara do Jury/Administration/Board of Directors of the Olinda Forum.

Some data were observed about the presented report, namely: a) According to the Ryznar stability index, the water in question presents a high incidence of corrosion in relation to CACO3, at a temperature of 28.9° C; b) the collection of samples and field tests when carried out by ITEP, follows the LQA-PT-03 procedure, and the environmental conditions recorded in a field worksheet; c) the pH, conductivity, dissolved solids and temperature parameters were analyzed at the Forum's facilities; d) environmental conditions: sun.

The obtained results indicate that the alkalinity of the water from the air condensers could not be used for human consumption, but it is suitable for use in non-noble purposes, such as washing patios and windows of the Forum.

3.1 Research Locus

The study consists of applied research in loco at the Lourenço José Ribeiro Forum (commonly known as the Olinda Forum), located at Av. Pan Nordestina, s/n - Vila Popular, Olinda - PE, CEP 53010-210, regarding the possibility of reusing wastewater from the air conditioners installed in this public building for non-noble purposes, such as washing external patios, washing panes and windows of that building. Figure 1 shows an image of the Olinda Forum.

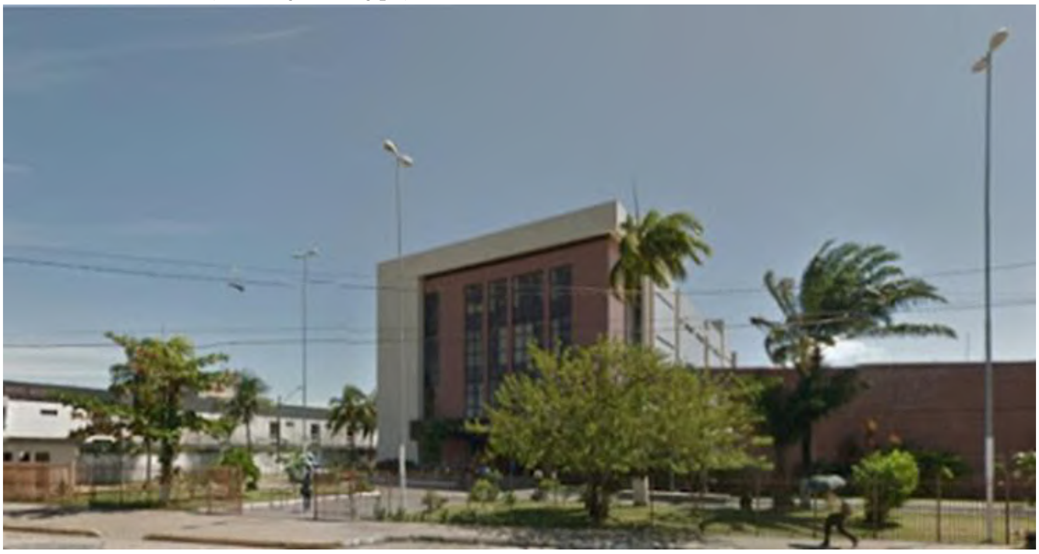

Fig.1 - The Lourenço José Ribeiro Forum (Olinda Forum) image

Source: Google Earth (2021)

Olinda city is 16 kilometers high above sea level and is 6 kilometers away from the state capital, in addition to possessing a surface area of 43,548 km2, integrating the micro-region of Recife, in the Metropolitan mesoregion. (TJPE, 2010, p.333). The location of the Forum of Olinda on the map can be seen in the figure.

In the municipal limits of Olinda are the Atlantic Ocean to the east; Recife city to the west and south, and Paulista city to the north. The local climate is hot and humid, with an average annual temperature of 27º C, and its territory is located between the Beberibe and Paratibe Basins. (OLINDA CITY HALL, 2021)

The hydric matrix of Olinda city is composed of the coastal coast with the Atlantic Ocean, the Beberibe River, the following tributaries in the Beberibe Basin: Lava Tripa Channel, Azeitona Channel, Malaria Channel, Lagoas de Jardim Brasil 3, Lagoa de Santa Tereza and Lagoa da Pulsação, and in the Paratibe Basin it has the tributaries Riacho da Mirueira, Riacho Fragoso (Piaba de Ouro), Riacho Ouro Preto, Bultrins Channel, Bultrins Fragoso Channel, Tintas Channel and Fragoso Lagoon. (OLINDA CITY HALL, 2021)

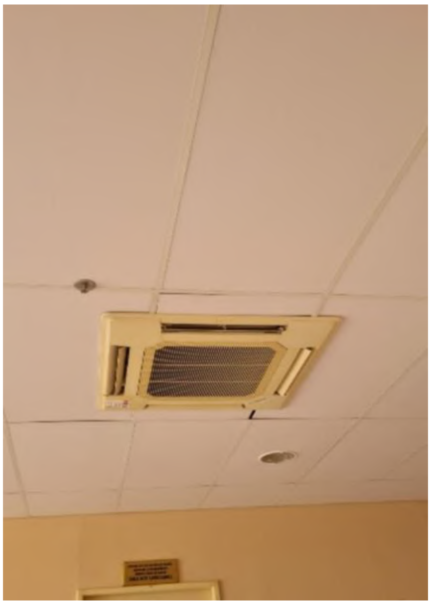

Fig.7 - Split Cassette air conditioning type used in the Lourenço José Ribeiro Forum

Source: Own collection (2021)

The Olinda Forum has a built area of 7,500.00 m², spread over four floors, comprising a ground floor - with a parking area for magistrates and service vehicles - and another three upper floors. The venue has a Jury room, bank, four cells, four elevators, access for the disabled, event room, and parking for 120 vehicles in the outdoor area. (SILVA, 2020)

In addition to the administrative facilities, there are three Criminal Courts, five Civil Courts, three Family and Civil Registry Courts, a Succession and Public Registry Court, two Public Treasury Courts, a Court of Domestic and Family Violence against Women, a Jury Court, a Childhood and Youth Court, in addition to a Judicial Center for Conflict Resolution and Citizenship (CEJUSC). (TJPE, 2021)

3.2 Analysis of the water quality of air conditioning condensers

The present case study is based on the laboratory verification of the physical-chemical properties of the water produced by the air conditioners of the Lourenço José Ribeiro Forum (Olinda Forum), in an attempt to understand the possible reuse applications of this water resource. It was necessary to verify the degree of nobility of the condensed water, so that its reuse can be in line with the chemical adaptations.

The Olinda Forum has 293 VRF System type air conditioners, and the research aimed at the physical-chemical analysis of 01 (one) sample (code 29840) of water expelled from the air conditioner (VRF System type) of the Vara do Jury/Administration/Board of Directors of the Olinda Forum.

Qualitative analysis included the physicochemical parameters and followed the requirements of the procedures established by the Standard **Methods for the Examination of Water and Wastewater (2017)** as described in Table 1X.

Parameter	Unity	Method
Bicarbonate alkalinity	mg/LCaCO3	2320 B
Carbonate alkalinity	mg/LCaCO3	2320 B
Alkalinity of hydroxides	mg/L CaCO3	2320 B
Total alkalinity	mg/L CaCO3	2320 B
Total calcium	mg/L Ca	Normative Instruction No. 30, of June 26, 2018
Chlorides	g/100g	3120 B
Conductivity	µg/cm	2510-B

Free carbon dioxide	mg/L CO_2	4500-CO2-C
Total hardness	mg/L CaCO3	2340 B
Total iron	mg/L Fe	Método 330 K
Ryznar Index	-	Cálculo
Total magnesium	mg/L Mg	2340 B
pH	-	4500- H+B
Total dissolved solids	mg/L	2510 A
Temperature	ºC	2550 B

IV. RESULTS AND DISCUSSION

Once in possession of the qualitative-quantitative surveys indicated above, it is important to discuss the results of this work and elaborate possible discussions according to the general and specific objectives mentioned above.

The potential reuse of condensed water is linked to the physical-chemical results, because the applications of this water resource need to be suitable for an use that supports the components of cooling water, such as pH and alkalinity, among others. In this sense, in chorus with the majority doctrine, the reuse of condensed water must be destined for the so-called non-noble purposes, which is exemplified as those that are used in cleaning services for external environments and decorative purposes, such as water mirrors and fountains. There are also less common industrial applications for the reuse of water dripped from air conditioners; in these cases, they can be useful in the cooling of boilers, or in the heating of vats in restaurants in the self-service format.

The motivations for the search for solutions and alternatives that can reduce water stress are evidently important. Even if renewable, quality and potable water resources are scarce. Alternatively, reuse can help reduce the use of potable water for activities that do not require potability. (MOURA *et al.*, 2020, p.791)

In Brazil, reused water is being used in several non-potable activities, such as agriculture, landscape irrigation, urban cleaning, vehicle washing and toilets in shopping malls. (MOURA *et al.*, 2020, p.792)

It is known that air conditioners perform condensation when they remove moisture from the air, generating a certain amount of water that is released through the drain and goes to the ground or sewer. The reuse of water from devices that release a certain flow contributes significantly to the rational use of potable water. Thus, collection projects in buildings that use drinking water in large proportion, add up to a productive and effective portion in the general aspect. (RIGOTTI, 2014; CAMPOS *et al.*, 2019, p2)

In addition to the evident softening of the water stress that affects the planet, it is necessary to remember that the uncontrolled dripping of air conditioning water is capable of causing structural damage to facades and sidewalks, in addition to infiltration problems, depending on the location of the condensers. Add to that the water waste from a source that could be reused if it had the necessary storage technology.

The collection of waste water in air conditioners is of paramount importance, because in addition to promoting the economy of this substance essential for life, it probably avoids the early deterioration of masonry, especially in public buildings, generating savings for public coffers. Furthermore, not allowing water to pool on the sidewalks contributes to the work of combating the proliferation of disease vectors, such as urban pigeons *(Columba livia)*. (ORTIZ *et al.*, 2021, p.25140)

Air conditioning equipment is used on a large scale in school, commercial and residential buildings, making the amount of water generated by the total number of appliances considerable, allowing the collection and reuse of the same in its various purposes, such as washing floors and flushing toilets. The technique of water reuse will depend on the medium from which the water was generated and its final destination, whether or not it is for human consumption. For such, it must meet criteria established by the Ministry of Health through Ordinance No. 2914 of December 2011, which aims to have procedures related to the control and surveillance of the water quality for human consumption and its potability standard. (CALDAS and CAMBOIM, 2017, p.168)

Despite the fact that Brazil does not have specific legislation that deals with the reuse of water from air conditioning units, it is worth noting that the reuse of water sources for non-potable purposes has already been dealt with in a more elaborate way in recent years by the Brazilian Association of Technical Standards (ABNT) through NBR 16782, NBR 16783 and NBR 15527.

In this sense, the efficient use of water was contemplated, in 2019, with a consistent increase in the normative reference framework. Two new ABNT standards were published, namely: ABNT NBR 16782:2019, which deals with water conservation in buildings, with requirements, procedures and guidelines; and ABNT NBR 16783:2019, which provides for the use of alternative sources of non-potable water in buildings. These documents, together with the ABNT NBR 15527:2019 standard, which endorses rainwater for the use of roofs in urban areas for non-potable purposes, in addition to disciplining its requirements, whose revision was published in April 2019, support the application concepts of conservation and replacement of water sources in buildings. (ZANELLA and ALVES, 2020, p.1)

NBR 16782 defines water conservation in buildings as the set of actions that, in addition to optimizing the operation of the building system in order to reduce the amount of water consumed (demand management), also promote the use of water from alternative sources to potable water provided by the public or private system (supply management). In general, water demand management seeks to promote actions directly in the hydraulic system so that less water is used in carrying out the same activities. Supply management, in turn, focuses on reducing consumption of potable water by replacing sources in specific processes. (ZANELLA and ALVES, 2020, p.1)

NBR 16782 cites as fundamental steps for the adoption of water conservation practices, the water characterization of the building, which is based on the understanding of the water cycle in the building from the water balance, and the elaboration of the supply and demand matrix of potable and non-potable water, bases for carrying out the technical and economic feasibility study that will guide the selection of applicable technologies and practices. (ZANELLA and ALVES, 2020, p.2)

Notwithstanding the aforementioned ABNT NBR are silent on condensed water and lists various sources of non-potable water such as rainwater; pluvial water; water table lowering; gray waters; dark gray waters; black water and sanitary sewage. It is imperative to point out that the dripping water from the air conditioners can serve the same hydric purposes and also collaborate with the reduction of the potable sources uses for non-noble applications. Naturally, the physicochemical composition admits variations of compounds, however, its use for non-potable purposes is adequate.

The main uses provided for by the NBR 16782, NBR 16783 and NBR 15527 standards for water from non-potable alternative sources are: flushing toilets and urinals; washing floors, patios, patios, garages; vehicle washing; irrigation for landscape purposes; ornamental use (fountains, fountains and lakes); water cooling systems and roof cooling. As for other unforeseen uses, the standards recommend that specific quality parameters must be evaluated for each situation by the professional responsible for the system design. The new regulations establish quality standards for water from alternative sources so that it can be used for the specified non-potable purposes. In order to reach the values of the required quality standards, the waters must undergo adequate treatment. (ZANELLA and ALVES, 2020, p.2)

Bearing in mind that the scarcity of drinking water is a topic on the agenda in contemporary environmental discussions, it is necessary that all contributions are considered economically. In this sense, the reuse of condensed water from air conditioners can contribute to the reduction of potable water resources in activities that do not directly depend on the potability of water to be carried out.

4.1 Test report and technical comments on sample results

The results of the cooling water examination considered the following variables: bicarbonate alkalinity, carbonate alkalinity, hydroxide alkalinity, total alkalinity, total calcium, chlorides, conductivity, free carbon dioxide, total hardness, total iron, Ryznar index, total magnesium, pH, total dissolved solids and temperature. Figure 9 shows the result of this examination of the cooling water, as well as its parameters and units.

Fig.9 - Condensed water results from the Jury Room of the Fórum Lourenço

Parameter	Results	Unity
Bicarbonate alkalinity,	6,75	mg/LCaCO3
Carbonate alkalinity	0,00	mg/LCaCO3
Hydroxide alkalinity	0,00	mg/L CaCO3
Total alkalinity	6,75	mg/L CaCO3
Total calcium	1,01	mg/L Ca
Chlorides	<0,5	g/100g

Conductivity	36,1	µg/cm
Free carbon dioxide	2,2	mg/L CO_2
Total hardness	3,59	mg/L CaCO3
Total iron	<0,05	mg/L Fe
Ryznar index	14,6	-
Total magnesium	<0,5	mg/L Mg
pH	6,55	-
Total dissolved solids	17	mg/L
Temperature	28,9	ºC

Source: LQA (2021); Author/ITEP (2021)

Cunha and Faria (2012) developed a qualitative-quantitative survey of condensed water from air conditioners at the Information Technology Department and the Administration and Planning Department. A physical-chemical analysis was carried out, where parameters such as ph, alkalinity and hardness were observed. It was also inferred that the water that is usually discarded has a high possibility of reuse for non-potable uses, such as landscape irrigation.

Melo (2020) elaborated his study on air conditioning units in a hospital typology building located in the city of Recife-Pe. It was found that the result of water collection presented a pH content below the standard that the law requires for human consumption (pH of 5.60), which would require a simple pH change through lime hydrated to reach the values imposed by the Ministry of Health Ordinance No. 2,914/11. However, the physical-chemical parameters satisfy non-potable needs, such as floor washing and water replenishment in the cooling tower of the air conditioning system.

Carvalho *et al* (2016) had as mainstay for their study elements collected from the air conditioners of Block "B" of the Catholic University of Pernambuco (Unicap). The parameters of pH, alkalinity, chlorides, conductivity, hardness and turbidity were analyzed. Two samples were taken for the research where it was obtained in sample 1 and in sample 2, the pH 6.68 and 6.7, respectively. Thus, such values are not within the standards required by the Ministry of Health Ordinance No. 2,914/11 for human consumption, but can be used for cleaning the institution and sanitary discharge.

It appears that the electrical conductivity is related to the presence of ions dissolved in the water, which are electrically charged particles. The greater the amount of dissolved ions, the greater the conductivity. Conductivity depends on the following factors: presence, concentration, mobility and valence of ions, as well as temperature. This parameter does not specifically determine which ions are present and only the amount of ions in the water, but it may contribute to the recognition of the water quality pattern, depending on the destination to which it is given. (SOUSA, ROCHA and MORAES, 2016, p.45)

Chloride ions are present in raw and treated water in concentrations that can vary from small traces to hundreds of mg.L-1. They are usually present in the form of sodium, calcium and magnesium chlorides. Conventional water treatment methods do not remove chlorides. Its removal can be done by demineralization or evaporation. (FUNASA, 2009; SOUSA, ROCHA and MORAES, 2016, p.45)

The final data from the laboratory examination presented here also indicate that, according to the analyzed sample, the water collected from the air conditioning has a high incidence of corrosion in relation to CaCO3, at a temperature of 28.9ºC. Furthermore, it is necessary to note that the pH, conductivity, dissolved solids and temperature factors are data captured *in loco*, that is, they are the conditions verified in the facilities of the Olinda Forum building, which still does not have any adequate capture and storage system of condensed water, despite its capacity to do so, given the high number of air conditioners installed in the building. Figure 10 shows the final data from the laboratory exam.

Taking this guideline into account, the study carried out by Souza (2019), taking into account the minimum volume of storage, for a period of 12 (twelve) months, identified a possible reduction, in reais, in water consumption at the Lourenço José Ribeiro Forum, based on the tariff structure of Companhia Pernambucana de Saneamento (COMPESA) practiced at the time.

Table 1 - Total annual volume of the air conditioning system of the building under study

number of months per year (12 months)	Total annual volume (l)		
	Minimum	estimated	Maximum
Total monthly volume (l)	45.463,00	47.713,60	49.970,80
total annual volume (l)	545.556,00	572.563,20	599.649,60

Source: Souza (2019).

Table 2 – Anual Reduction

Consumption			Value R$
up to	1	62,67	62,67
Above	545,556	9,50	5.182,78
		Annual economy	5.245,45

V. FINAL CONSIDERATIONS

The search for alternatives that offer efficiency in the (re)use of water resources must be shared by all civil society, companies and the State. The excessive wear and tear of the water matrix in the world triggers the need to seek new alternatives and solutions to meet the needs for water with the maximum efficiency and the minimum possible waste. In this sense, the reuse of some water sources is presented as a valuable alternative to the efficient and rational application of water.

Condensed water from dripping air conditioners is on the list of plausible sources to be reused along with rainwater and gray and black water.

In buildings that have complex cooling systems, equipped with numerous units of air condensers, the reuse of residual condensed water is shown as an enabler of reducing the use of drinking water in activities that, despite demanding the consumption of that water resource, would not necessarily need to be supplied by potable water.

These water purposes are considered non-noble and can be exemplified in the water use for washing floors and patios, cleaning windows, flushing toilets and landscaping equipment such as fountains and water features. It should be noted that in addition to the common applications set out here, condensed water is also possible for reuse in commercial and industrial activities such as boiler cooling and disposal in self-service restaurant vats.

The use of the water that drips from the air conditioners reveals itself, therefore, as a valuable matrix of hydric resource that would not require consumption of potable water. In the name of this relevance, State Law n.16.584 was published in Pernambuco in 2019, which determines the mandatory collection, storage and use of condensed water in private buildings for public use, such as malls, markets, etc.

Although the aforementioned normative forecast does not link this reuse of drip water in buildings owned by the Public Power of the State of Pernambuco, it is certain that government spheres have their own links to environmental sustainability initiatives that place the reuse of condensed water in the planning and future strategies of the Brazilian public administration. Thus, the trend of normative advancement is directed towards the standardization of the condensed water reuse as a rule to be observed both by the private sector and by the public sector so that the whole society contributes to the improvement of consumption and reuse of all available water inputs.

It is also worth noting that the Brazilian Association of Technical Standards (ABNT) has published in recent years some technical standards related to the reuse of water for non-potable sources, namely: NBR 15527:2019 - Use of rainwater from roofs for non-potable purposes - Requirements; NBR 16783:2019 Use of alternative sources of non-potable water in buildings; and NBR 16782:2019 - Water conservation in buildings - Requirements, procedures and guidelines. Despite the lack of mention of the condensed water reuse, it is worth mentioning the existence of normative instruments that improved the standardization of reuse for various wastewater, as an example of what happens with rainwater; water table lowering; gray waters; dark gray waters; black water and sanitary sewage.

In this sense, the reuse of condensed water from the Lourenço José Ribeiro Forum is aligned with the environmental preservation proposals that currently link public administration decisions and projects, but which need to advance on the subject. The constitutional basis gives the environment the prerogative of defense by the Public Power and, therefore, any and all initiatives aimed at promoting sustainability must be taken into account.

The measures recommended by the United Nations on sustainable development that are mentioned in the TJPE Strategic Plan for the 2021-2026 years, and also in the Sustainable Logistics Plan make up the dialogue between international and local guidelines for environmental protection and improvement of decisions that weigh the sustainability factor in the decision-making of the Pernambuco Judiciary. In both documents, the consideration of reducing consumption and improving the reuse of water resources used in justice buildings remains through smarter systems that can guarantee a balanced use that does not demand from the environment anything more than what is due at the moment of application of this natural good and, when possible, that the inputs already used are reused in order to reduce the level of waste produced by public buildings.

The intention of the Judiciary is to become a house of sustainability promotion. Since the Public Power sets the example that companies and civil society must follow, the vanguard of adaptations of the daily life of public buildings to socio-environmental reverence seeks to bring to the heart of Brazilian society the consideration of such premises. Therefore, every forum can be a catalyst and an example to be followed in good practices, environmental technology and sustainable governance.

The present case study, dedicated to evaluating the potential for reuse of dripped water from air conditioners at the Forum Lourenço José Ribeiro (Olinda Forum), sought to promote reflection on the waste of an opportune source of non-potable water that, even offering the appropriate physical-chemical conditions to be reapplied in non-noble water activities, it is not being spared or considered as a valid alternative of financial and environmental savings to the Olinda Judiciary.

It should be reiterated that the wastewater reuse from the air conditioners of the Olinda Forum has an intrinsic relationship with the normative provisions listed in the TJPE Strategic Plan for the 2021-2026 years and also in the TJPE Sustainable Logistics Plan to promote the reduction of water consumption and reuse of water sources that supply the Brazilian courts, worth ratifying that such documents are a direct result of the guidelines coming from the National Council of Justice and also from the Sustainable Development Goals of the 2030 Agenda promoted by the United Nations on the indispensable improvement in the use, reuse and reduction of goods extracted from nature consumption.

In this way, socio-environmental responsibility brings together both environmental and material interests regarding a possible reduction in the drinking water bill, if the wastewater from the air conditioners were reused in the Olinda Forum.

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