Revista Ibero-Americana de Ciências Ambientais
Ibero-American Journal of Environmental Sciences

Maio 2022 - v.13 - n.5

ISSN: **2179-6858**

This article is also available online at:
www.sustenere.co

Analysis of the impact of technology on wastewater reuse at forum Des. Rodolfo Aureliano

Water is a finite resource and its scarcity has worsened due to population growth, lack of management and sustainable use of natural resources. The United Nations recognizes that water reuse is a safe solution for meeting the water needs of the world, establishing this practice through the 2030 Agenda as a fundamental tool for achieving one of the Sustainable Development Goals. Wastewater reuse technology, through sewage treatment plants (ETE), is a sustainable solution to help rationalize water use and reduce demand for springs. This research is based on one of the technologies for the reuse of wastewater and aimed to analyze the impact of the implementation of the technology in the reuse of wastewater from the sewage treatment plant in the Forum Desembargador Rodolfo Aureliano, located in the Joana Bezerra neighborhood, city of Recife PE. The obtained results proved the relevance of the studied impact attributed to ETE, demonstrating the promotion of relevant environmental and economic benefits. It shows, as a result, that the reuse system is effective for feasibility, considering the volume of 280.00 m³/day of treated sewage, for use in the irrigation of the building green areas, in an extension of 9,261 m², representing a monthly saving of 370,440 liters of drinking water. Thus, the importance of implementing public policies that promote effective actions on sustainable water management practices, especially in public buildings, is highlighted, which is an important path for environmental management.

Keywords: Effluent; Scarcity; Sanitary Sewage; Sanitation.

Análise do impacto da tecnologia no reúso de efluentes no fórum Des. Rodolfo Aureliano

A água é um recurso finito e sua escassez tem se agravado devido ao crescimento populacional, falta de gestão e uso sustentável dos recursos naturais. A Organização das Nações Unidas reconhece que o reúso de água é uma solução segura para atender às necessidades hídricas do mundo, estabelecendo essa prática por meio da Agenda 2030 como ferramenta fundamental para o alcance de um dos Objetivos de Desenvolvimento Sustentável. A tecnologia de reúso de efluentes, por meio de estações de tratamento de esgoto (ETE), é uma solução sustentável para ajudar a racionalizar o uso da água e reduzir a demanda por mananciais. Esta pesquisa tem como base uma das tecnologias de reaproveitamento de efluentes e teve como objetivo analisar o impacto da implantação da tecnologia no reaproveitamento de efluentes da estação de tratamento de esgoto do Fórum Desembargador Rodolfo Aureliano, localizado no bairro Joana Bezerra, cidade do Recife PE. Os resultados obtidos comprovaram a relevância do impacto estudado atribuído à ETE, demonstrando a promoção de relevantes benefícios ambientais e econômicos. Mostra, como resultado, que o sistema de reaproveitamento é eficaz para viabilização, considerando o volume de 280,00 m³/dia de esgoto tratado, para uso na irrigação das áreas verdes prediais, em uma extensão de 9.261 m², representando uma economia mensal de 370.440 litros de água potável. Destaca-se, assim, a importância da implementação de políticas públicas que promovam ações efetivas sobre práticas sustentáveis de gestão da água, principalmente em prédios públicos, sendo este um importante caminho para a gestão ambiental.

Palavras-chave: Efluente; Escassez; Esgoto Sanitário; Saneamento.

Topic: **Uso de Recursos Naturais**

Reviewed anonymously in the process of blind peer.

Received: **09/05/2022**
Approved: **30/05/2022**

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DOI: 10.6008/CBPC2179-6858.2022.005.0023

Referencing this:
REIS, J. B.; CORDEIRO, L. F. A.; SANTOS, L. A.; SILVA, M. D.. Analysis of the impact of technology on wastewater reuse at forum Des. Rodolfo Aureliano. **Revista Ibero Americana de Ciências Ambientais**, v.13, n.5, p.306-322, 2022. DOI: http://doi.org/10.6008/CBPC2179-6858.2022.005.0023

INTRODUCTION

Water is a natural resource necessary for the survival of life on earth, fundamental for the maintenance of life and of paramount importance for various economic activities, playing a significant role in sustainable development. Although we know that water is vital for the balance of the entire ecosystem on earth, water is a limited resource and its scarcity has worsened due to population growth, lack of management and sustainable use of natural resources (SMOL et al., 2020).

The surface of the planet is 70% composed of water. However, most of it is salt water, with only 3% of all this water being freshwater, and less than 1% is safe for consumption (ANA, 2022). It is currently one of the most discussed environmental problems, mainly due to the possibility of the lack of this resource. The problem of lack of water is not only restricted to the lack of rain, but also due to the development processes practiced without planning since the Industrial Revolution, as a result of economic development, increase in the world population, causing the growth of human consumption needs, allied to the mistaken thought of water resources as an infinite good (GOMES et al., 2021).

Considering the increase in cities and the consequent population growth, linked to water management practices, it is estimated that the demand for water on the planet will be reduced by 40% in relation to its supply by 2030, according to the World Bank. This is due to the urbanization process of cities, with the increase in populations and the implementation of industries, which are large consumers of water, thus becoming an important factor in the process of water scarcity (ZHOU et al., 2021).

According to UNESCO estimates (2018), by 2050, about 5.7 billion people will suffer from water scarcity due to society's lack of responsibility for water use. Therefore, solutions based on natural processes are essential for sustainable development. However, despite the potential to improve the performance of established water infrastructure, these structures are still underexplored.

Bearing in mind the increase in per capita water consumption and the growth of the world population, especially in developing countries, concerns about water scarcity and pollution are increasing significantly. This is justified because in places where basic sanitation is inadequate, several pollutants end up being released into water bodies without any type of treatment (UNESCO, 2018).

Despite knowing all the importance that water has for humanity, many still do not care about its preservation, forget that water is a limited resource, and continue to pollute rivers and springs. According to UNICEF data (2019) it is estimated that more than 2.1 billion people (30% of the world population) do not have access to safe drinking water and 4.4 billion people (60% of the world population) do not have safe basic sanitation in minimally satisfactory conditions.

Much has been said about the water crisis, a worldwide problem. This is due to several problems, such as the pollution of contaminated rivers and unsuitable for human consumption by the deposit of sewage, garbage and waste from industries, the poor distribution of this resource, the indiscriminate use in industries, the inappropriate use and the worsening problems (GOMES et al., 2021).

In the Brazilian semi-arid region, this situation is aggravated due to the high periods of drought. One of the alternatives for mitigating this resource is the controlled reuse of wastewater, already widespread in much of the world (FERREIRA et al., 2020), which can bring economic, social and environmental benefits to communities.

In agriculture, where world water consumption is approximately 70%, including the diversion of rivers and underground pumping (TORRES, 2019), the reuse of wastewater becomes a great alternative, directing better quality water to nobler ends.

Thus, we must be aware of the limitation of water available for our consumption. It is necessary for society to have more conscious attitudes in the management of water use, and for governments to increasingly seek to use resources in the implementation of structural and efficient public policies, whether in the use of water reduction and reuse practices, or in promoting awareness campaigns, and also in the inspection of the productive sectors to carry out a more conscious consumption of water in their production activities (FONSECA et al., 2020).

Wastewater reuse technologies are sustainable solutions and contribute to the rational use of water, reducing the demand on water sources. It is noticed that many enterprises do not install a wastewater treatment plant due to ignorance of the reuse proposal, due to high implementation costs. The conscious use of water is a healthy practice, which, combined with technological methods for its reuse, promotes both financial and socio-environmental gains (CARRASQUEIRA et al., 2019).

The United Nations (UN) recognizes that reuse water is a safe solution for the supply of water demand in the world, establishing this practice through the 2030 Agenda, as a main tool to achieve one of the Sustainable Development Goals.

This research is based on the analysis of the impact of technology implementation on wastewater reuse through a compact effluent treatment plant, at the Forum Desembargador Rodolfo Aureliano, which has as its principle the extraction of pollutants from the water, which are retained or transformed into other elements or compounds. This water is disposed of in the environment in a watercourse, but it can also be reused in secondary activities such as irrigation of green areas, floor and vehicle washing and in sanitary and urinal discharges, thus guaranteeing the environmental balance, being an alternative priority for achieving the Sustainable Development Goals (SDGs) for 2030, such as ensuring universal access to safe drinking water and reducing the number of people who suffer from water scarcity.

The general objective of this work was to analyze the impact of implementing the technology on the reuse of wastewater from the sewage treatment plant in the Forum Desembargador Rodolfo Aureliano.

THEORETICAL REVIEW

Water reuse in brazil and the world

Planet Earth is covered by 1,315 cubic km of water, of which 0.003% is fresh water suitable for human consumption and for use in agriculture and industries. Although we have an abundance of water, many people still do not have access to this good, either because of the great distances for the populations, or because of the difficulty in capturing it for consumption. It is estimated that by the year 2030, the world population will grow by around two billion, at an effective rate of 1.2% per year (WINPENNY et al., 2010).

According to the National Sanitation Information System-SNIS, Brazil has about 12.0% of the planet's fresh water, with an unequal distribution between its regions. The North macro-region, with a smaller population, is the one with the greatest availability of water. However, the Southeast and Northeast regions have less than 10% of the amount needed for the consumption of about 69% of the population (BRASIL, 2019a).

The growing population causes great concern regarding the problems linked to it, such as, for example, the lack of planning in cities, the demand for water for consumption, as well as the pollution and contamination of water resources (RYTCHYSKYI et al., 2021).

Factors such as prolonged drought, climate variability, in a region, related to natural causes, high rate of urbanization and population growth, aggravate the suffering associated with water scarcity. This leads, in a certain period of time, to a reduction in the need for water and the need for alternatives for the supply and sustainable management of water resources (PAVOLOVÁ et al., 2019).

The negative effects of the water crisis, such as water shortages, have caused many losses of people in rural Australia. These effects have been worrying many countries in dealing with the problems of the water crisis, which have sought sustainable alternatives for water management and supply, such as the implementation of water reuse systems, the desalination of seawater and brackish groundwater to confronting the water scarcity (SHOUSHTARIAN et al., 2020).

China, in 1973, concerned with the problems of wastewater pollution in the environment, the implementation of wastewater treatment systems was started, flourishing until the present day, with the development of alternatives for the reuse of these waters and consequent awareness of chinese people on environmental protection (XU et al., 2020).

The lack of good quality water resources is influenced, among other things, by the large population increase and disorderly urbanization, climate change, unconscious consumption and water pollution. The intensity of water scarcity, whether in a single region or across the country, is measured using the water stress index, which is calculated as the ratio of annual groundwater and surface water abstractions and total renewable water resources. Arid, semi-arid and subsumed droughts cover 40% of the total area of the planet (UNGUREANU et al., 2020).

The scarcity of water intended for consumption is already considered one of the most serious problems in the world. To avoid wide ranges of supply shortages in consuming regions, water managers must urgently implement effective water shortage plans. Even if severe water scarcity is not eliminated, the causes of persistent water scarcity await urgent and necessary conditions, allowing mitigation actions to help delay its onset (WANG et al., 2019).

The problems of global water scarcity greatly affect the unequal distribution of water resources. Excessive consumption of water compared to the availability of water implies the availability of water demand in the rivers, in the dry season periods, also reducing the levels of groundwater. Large consumers of water, such as power generation and agricultural activities, have a significant impact on the water crisis, especially in urban areas (ZHOU et al., 2021).

According to data from ANA (2019), in Brazil, in 2018, 2,516 drought events were recorded, affecting 43 million people, of which 90% are in the Northeast region. Although Brazil is one of the countries with the greatest water availability, water management is still considered uncertain (SANTOS et al., 2020).

In the context of water scarcity, more than 2 billion people live in countries with severe water scarcity (UNESCO, 2019), and about 4.0 billion people live under extreme water pressure for at least 1 month a year, around the world. Demand for water is estimated to more than double the number of people in some parts of the world. All this is a result of population growth and increased demand for food, where agriculture consumes large amounts of drinking water, in addition to climate change. As a result, water scarcity and long periods of drought turned into a global problem, no longer just an issue exclusive to arid and semi-arid regions (LEONEL et al., 2021).

Since the 1980s, water consumption has been increasing worldwide at a rate of about 1% per year, due to socioeconomic development combined with population growth and consequent changes in consumption patterns. As a result, estimates indicate that global water demand will continue to grow at the same rate until 2050, which will represent an increase of 20 to 30 percent from the current level of consumption, mainly due to increased domestic and industrial demands. According to the UN (2019), Figure 1 provides a view of countries experiencing levels of water stress, the annual proportion of total drinking water withdrawn by major sectors, including environmental water needs, and the total amount of renewable water resources, expressed as a percentage (UNESCO, 2019).

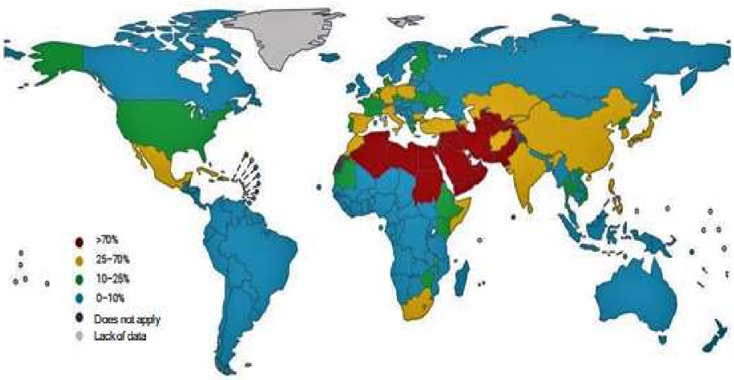

Figure 1: Physical hydric stress level. **Source:** United Nations World Report on Water Resources Development 2019. Leaving no one behind Facts and Data (UN, 2019).

Sewage treatment

When discarded in the environment without treatment, waste can unbalance ecosystems, significantly altering the characteristics of soil and water, causing major impacts on pollution and polluting processes.

One of the main sources of pollution of water courses is sewage, which compromises water quality and the balance of the environment, being a concern for the life of aquatic living beings due to the reduction of oxygen in the water caused by the decomposition of organic matter by bacteria, releasing large amounts of dissolved oxygen into the water (BRASIL, 2020).

Therefore, in view of the accumulation of wastewater in water bodies, there is a decrease in oxygen and fish death, in addition to damage to recreational activities. This phenomenon, called eutrophication, is caused by an excessive load of nutrients in the water, resulting in abnormal algae growth.

Even so, the concern in managing the pollution of water courses through sewage treatment systems is still little explored by the entrepreneurs of the activities that generate effluents. In addition, pre-treatment through sewage treatment plants will ensure that water can be recycled within the company itself, which brings an economically effective strategy (FERNANDES et al., 2020).

The options for implementing the treatment processes of an Effluent Treatment Station-ETE are not limited to legal or public health issues and environmental issues. In addition, economic, social, operational aspects, areas of availability and even community aspirations must be considered (ANA, 2017).

In Brazil, according to data from the ANA Sewer Atlas (2017), 2,768 sewage treatment plants were identified in operation in 1,592 cities, serving a population of approximately 71.7 million inhabitants. With this, the identification of the BOD load removal efficiencies for 96% of the Sewage Treatment Stations was provided, which in some situations showed different values of the efficiencies found in the literature. Of this total of investigated ETEs, distributed throughout the country, ETEs with average BOD removal efficiency in the range of 60 to 80% are more predominant (ANA, 2017).

Wastewater treatment operations are commonly performed by physical, chemical and biological processes. However, a combination of these operations is often used, because with the release of waste into water bodies where the natural purification processes are developed, other combinations of operations are used, allowing the necessary conditions for a better efficiency of the discharged sewage treatment (LISBÔA et al., 2020).

The reuse of wastewater is based on regulations and guidelines from the World Health Organization-WHO, and currently many countries already have their own legislation based on these WHO regulations. However, the United States Environmental Protection Agency (EPA) is one of the most important regulatory agencies in environmental legislation, due to strict reuse restrictions, including specific requirements for industrial reuse (ŠRÁMKOVÁ et al., 2018).

According to ANA (2020), it is relevant to consider the release of sewage, especially untreated domestic sewage, into water bodies, because due to the pollution of water bodies, it can make water unavailable, aggravating the critical situation of the water balance. According to data from the SNIS (2019), 61.9% of the country's urban population is connected to the sewage collection network, and 54.1% of the total sewage collected is treated.

Figure 6 shows the distribution of the service rate with public sewage networks distributed by percentage ranges, by state (total and urban % by geographic macro-region, in 2019), indicating the criticality of the situation, since only three regions have a percentage of attendance greater than 50%.

Sewage Treatment Station - ETE

The sanitary sewage system is defined by a set of activities and installations for the collection, removal, cleaning and final disposal of sewage, which allows for the adequate treatment of effluents generated by the contributions of a community.

The technical specifications of the system to be adopted must meet the expectations of an organization and, of course, the Regulatory Norms and appropriate technical decisions, whether at state, regional or municipal level, aligned with the environmental objective of the effluent generating body. According to WESA (2017), in order to achieve the efficiency of wastewater treatment, the following assumptions must be considered in the design of a Sewage Treatment Station: guarantee of the final quality of the effluent in the protection of water resources close to the enterprise; easy operation of the system; low energy consumption; smaller number of units, reducing the cost of implementation without compromising the quality of the process and its final product; longer useful life of equipment, in order to avoid downtime, promoting aesthetic quality of the system, in addition to reducing costs with preventive and corrective maintenance; total odor control.

In Brazil, according to environmental agencies, the ETE is one of the most suitable processes for the treatment of sanitary effluents due to its high treatment efficiency, and its principle is the extraction of pollutants from water, organic matter, suspended solids and pathogens present in domestic sewage by through primary and secondary treatment processes, and, in some cases, advanced treatments that can remove other elements such as nitrogen and phosphorus, important parameters for organisms present in water bodies (CARVALHO et al., 2020.), being released, after treatment, in a watercourse, in order to maintain the environmental balance, as well as being reused in secondary activities such as irrigation of green areas, sanitary discharges, washing of floors, observing the criteria of legislation and legal standards such as as CONAMA 357/05 with the amendments of CONAMA 430/11.

The sewage treatment stations-ETE, after physical, chemical and biological treatment of the wastewater, lead the effluents to the collection network and returned to the environment, which can be released into rivers, lakes or the sea (DINIZ et al., 2019).

According to ANA (2020), sewage treatment plants can significantly reduce BOD rates, considerably improving water quality. It can be observed that in cities like Brasília, which have a high percentage of service in sanitation and sewage treatment systems, they had low BOD values in 2018.

Thus, given the impact of the discharge of effluents from the ETE into water bodies, the companies that generate the waste must be concerned with the effects caused by the dumping of these effluents into water courses, mainly in compliance with environmental legislation, criteria and policies which are increasingly demanding more strict treatment levels, in order to ensure the minimization of the environmental impacts caused by the release of treated effluents into water bodies (CRIZEL et al., 2020).

The operation of a compact ETE consists of the following steps: Sewage treatment begins with the separation of liquids and solids. Then the sewage is transported to a box that removes the remaining sand

and grease residues. These residues are removed manually or mechanically and must be properly disposed of in a sanitary landfill. The subsequent process depends on the type of treatment system and can be divided into three levels: primary, secondary and tertiary, according to the degree of removal of the pollutant.

In the primary system, solids are retained, separating inorganic solids, preventing them from going to the ETE. With this, the suspended and sedimentable solids present in the sewage are removed. After the process in the solids retention box, the effluents will be transported to the biological treatment system.

In the secondary system, the dissolved organisms are removed by biological processes, with the digestion of organic matter by the microorganisms in order to stabilize them, removing them from the water. Through this process, the natural acceleration of the decomposition of organic pollutants occurs.

The removal of organisms, through biological processes, can be aerobic, which requires the presence of oxygen, or anaerobic, which does not require the presence of oxygen, in the treatment processes. Anaerobic activity transforms organic matter into carbon dioxide and methane gas at an organic removal rate of treatment around 60% to 75%.

With the action of aerobic microorganisms, the organic matter is decomposed and converted into carbon dioxide and water, this process being more efficient than the anaerobic one. In this process, air entry into the system must be ensured through air blowers, where air is introduced close to the bottom of the aerobic tank and part of the insufflated oxygen is transferred by contact to the liquid medium as the microbubbles rise to the surface. This process demands high costs in the consumption of electric energy.

Generally, sewage treatment plants use both types of processes, aerobic and anaerobic, to obtain maximum efficiency and, therefore, low levels of organic matter.

The tertiary system is used in the processes of sewage removal with inorganic compounds, such as nitrogen and phosphorus, of industrial properties and nutrient removal with concentrations difficult to be reached only in the secondary process. Depending on the required quality of the sewage and the technical and economic feasibility, the tertiary system can be carried out using chemical or biological products with the action of microorganisms or bacteria.

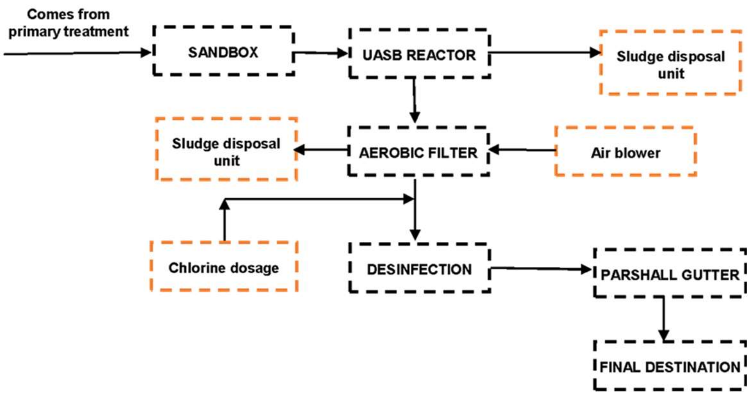

Figure 2: ETE operation flow. **Source:** WESA (2017).

The Forum Des. Rodolfo Aureliano sewage treatment plant is composed of a system in which the effluents will pass through a solids retention box, an effluent lifting station, where they will be fed by a lifting pump to a biostation for the treatment of the effluent, and later released into the receiving water body.

Figure 2 shows the operation flowchart of the ETE of Forum Des. Rodolfo Aureliano; it consists of a flow where the effluent passes through a sandbox, an anaerobic reactor, an aerobic filter and finally, a disinfection tank by contact with chlorine, following to the final destination.

In the solids retention box, the physical removal of suspended elements (plastic cups, lids and others) has the purpose of protecting the liquid transport devices in the pumping and piping system, the treatment devices, as well as allowing the usefulness and efficiency of the system and prevent raw effluents from being released into the receiving water body. These solid residues must be removed, by truck of the type septic tank, and sent to a licensed treatment plant.

When leaving the solids retention box and passing through the grating box, the effluents will be transported to the biological treatment system, through an elevating pumping system, leading the effluents to the vertical sand tank. This tank is installed at the entrance of the treatment system, and is intended to receive the effluents carried by the pump. The vertical sand tank is hydraulically designed to avoid sedimentation of organic matter in cases where up to 50% of the projected flow is used. In this process, heavy solids and sand will be retained in order to avoid clogging of pipes and silting of tanks, which can, in this case, reduce the useful volume and compromise the efficiency of the system.

From the sand tank, the treatment process begins through the anaerobic reactor, consisting of the passage of the ascending flow of effluents through a bed of dense and highly active sludge. The effluent enters at the bottom of the reactor and leaves the system through a decanter at the top. In this process, gases and solids are separated below the decanter, enabling the sedimentation conditions of the particles that separate from the primary sludge blanket, allowing them to return to the digestion area, preventing them from being transported out of the system together with the effluent. It is important that excess sludge is removed from the system in order not to cause damage to the other stages of treatment. Removal can be carried out through pumping to drying beds, centrifuges, thickeners or another process defined by the company controlling the treatment plant.

After treatment in the sand tank, component of the Forum Des. Rodolfo Aureliano ETE, in order to meet the needs of treating sanitary effluents, the vertical tanks, above ground, have the capacity to meet a flow of treated effluent of up to 280,000 liters per day. In this station, the biological treatment process is used, starting with an anaerobic stage and ending with an aerobic stage, providing high efficiency of pollutant removal at a tertiary treatment level.

The final stage of the treatment will be the disinfection of the effluent, aiming at the elimination of eventual pathogens still present in the effluent. In this stage, the chlorine contact process is used, producing treated effluents with the possibility of reuse in secondary activities such as irrigation of green areas, floor and vehicle washing, sanitary and urinal discharges and fire fighting.

Finally, the flow measurement of the sewage treatment system will be carried out by a Parshall type gutter. Afterwards, the treated effluent will be sent to the receiving water body, a channel next to the Forum, disposing these effluents to the Capibaribe River. However, in order for the effluent to be released into the water body, it is necessary to carry out periodic analyzes of this effluent in compliance with the requirements of environmental legislation.

Water quality parameters for the effluents release in the collecting net or water bodies

The performance indicators of a sewage treatment plant are important tools to evaluate the operating conditions, as well as the quality of the effluent, after treatment, according to the criteria of environmental legislation (RAMOS JÚNIOR et al., 2020).

According to Rice et al. (2016), confidence in the quality of recycled water remains an important factor in the acceptance of wastewater use, because although wastewater goes through a treatment process, it may still contain a small concentration of chemicals and pathogenic microorganisms in the post-treatment process. However, factors such as color, odor and turbidity are important for the acceptance of wastewater use (MONTE et al., 2010).

The procedures for monitoring the physical and chemical analyzes during the stages of the sewage treatment plant make it possible to verify and analyze the efficiency of the treatment system so that decisions can be taken for the implementation of preventive and/or corrective measures.

In order to guaranteeing the minimum quality standards, conditions and standards for effluent discharge, the National Environmental Council-CONAMA, through Resolution No. 430 OF 05/13/2011, which complements and amends Resolution No. 357, of March 2005, provides that "effluents from any polluting source may only be released directly into the receiving bodies after due treatment and provided that they comply with the conditions, standards and requirements set forth in this Resolution and in other applicable regulations" (CONAMA, 2011). Thus, in Art. 21 of CONAMA Resolution No. 430/2011, the conditions and standards for the release of effluents from sanitary sewage treatment systems are established: The PH must be in the range between 5 and 9; The temperature must be below 40°C. The temperature variation of the receiving body must not exceed 3°C at the boundary of the mixing zone; Sedimentable materials: up to 1 mL/L in 1-hour Imhoff cone test. However, for release into lakes and ponds, sedimentable materials should be virtually absent; 5 days Biochemical Oxygen-BOD demand, 20°C: maximum 120 mg/L. This limit can only be exceeded in the case of effluent from a treatment system with a minimum removal efficiency of 60% of BOD, or by means of a self-purification study of the water body that proves compliance with the goals of the framework of the receiving body; Hexane-soluble substances (oils and greases) up to 100 mg/L; Absence of floating materials.

The pH measurement indicates the acidity or alkalinity of the water. In the case of wastewater treatment, considerable changes in pH can affect the growth rates of microorganisms responsible for the self-purification of the water body (VON SPERLING, 1996).

The indication of the temperature in the wastewater treatment system represents the degree of the water particles agitation, and the greater this agitation, the higher the temperature, which may affect the amount of dissolved oxygen in the water. When the temperature is high, the amount of dissolved oxygen decreases, which can also affect the metabolism of microorganisms present in the water body. Therefore, it is important to control the temperature of the effluent for disposal.

The Biochemical Oxygen Demand (BOD) represents the content of organic matter present in sewage or water bodies and indicates the amount of oxygen required for the degradation of organic matter through biological processes. The BOD is important for assessing the degree of pollution of the water body (VON SPERLING, 1996). The measurement of high BOD rates indicates that large amounts of oxygen are required for the degradation of organic matter. While a lower BOD can characterize the absence of pollution and decomposing microorganisms.

Oils and greases, in addition to causing obstructions in pipes and sewage collection networks, also hinder biological treatment processes. Because it is much thicker than water, it accumulates on the surface, forming a film that prevents the exchange of gases between water and air and the penetration of light, preventing the photosynthesis of other microorganisms. Oils and greases can also envelop organisms, preventing them from breathing.

METHODOLOGY

Research location

The case study location was the Sewage Treatment Plants located in the building of the Forum Desembargador Rodolfo Aureliano (Figures 3 and 4), located in the Joana Bezerra neighborhood, in the city of Recife/PE. The study of this building is relevant because it is a public building, where water consumption is considerable, given that there is a large circulation of people.

Therefore, in buildings of this type, the need for water conservation is greater given the impact that these buildings represent for the public supply system. The Pernambuco Court of Justice has some Sewage Treatment Plants for reuse in operation and it is of fundamental importance to evaluate the production of wastewater suitable for non-potable reuse.

Figure 3: Forum Desembargador Rodolfo Aureliano location. **Source:** Adapted from Google Earth (2021).

Figure 4: Forum Des. Rodolfo Aureliano. **Source:** Google (2019).

It is important to highlight that the building (Figure 4) has a built area of 38,832.40 m², distributed over 6 (six) floors (Table 1), with a fixed population of 1,800 people, including servers, magistrates and outsourced personnel, and a floating population of approximately 5,000 people/day.

Table 1: Fórum Des. Rodolfo Aureliano Areas.

FLOOR	AREA (m²)
GROUND	40.015,58
NATURAL SOIL	9.261,00
PERMEABLE SOIL	5.060,00
GROUND FLOOR	9.149,00
1º FLOOR	6.005,75
2º FLOOR	5.443,00
3º FLOOR	4.862,90
4º FLOOR	4.657,10
5º FLOOR	4.714,65
TOTAL CONSTRUCTION AREA	**34.832,40**

Source: Adapted from TJPE (2022).

Methodological steps

The research was based on a mixed method configuration, a combination of qualitative and quantitative methods (PARANHOS et al., 2016), in an exploratory structure, carried out through data collection, as well as observation and collection of specific information from that work.

The first stage covers the accomplishment of a qualitative phase, of an exploratory nature, through the collection of bibliographic data, legislation and information related to the research object. The second stage comprises the quantitative assessment, through data collection, validation and analysis procedures.

Finally, a case study was carried out seeking to analyze the potential benefits for the sustainability tripod with the feasibility of reusing treated wastewater in the sewage treatment plant of the Forum Desembargador Rodolfo Aureliano.

RESULTS AND DISCUSSION

In this section, the results obtained regarding the supply of wastewater originating from the sanitary system and pantries of the investigated building are described.

Water Consumption

The Court of Justice of Pernambuco-TJPE, a major consumer of natural resources, in compliance with the Resolution of the National Council of Justice-CNJ, which ‘Provides for the sustainability policy within the Judiciary Power’, and in line with its Plan of Sustainable Logistics-PLS, created by Ordinance 18/2018, of September 25, 2018, has as its main objective: ‘To promote actions that strengthen the adoption of sustainability and economy criteria for the activities of the public administration of the TJPE’. In this case, two of the specific objectives of the PLS are: ‘Encouraging actions for the rational consumption of natural resources and public goods’ and ‘Contributing to the implementation of a culture of sustainability, through educational practices’. In this sustainable logistics plan, the TJPE defined Water and Sewage Management as one of the themes, and as an indicator for this theme, rationalizing the use of water.

The TJPE's concern with sustainable practices aimed at reducing water consumption can be seen through the PLS. Evidently, to date, there are no measures of greater impact aimed at the use of water in public buildings. Therefore, in view of this scenario, and considering one of the sustainability objectives adopted by the TJPE, 'Encouraging actions for the rational consumption of natural resources and public goods'. In addition, it is necessary to adopt environmental awareness strategies seeking to reduce water consumption in their buildings.

The first survey performed was through research on the costs related to the consumption of drinking water and sewage in the Forum Desembargador Rodolfo Aureliano of the Court of Justice of Pernambuco, from 2017 to 2021 (Figure 5).

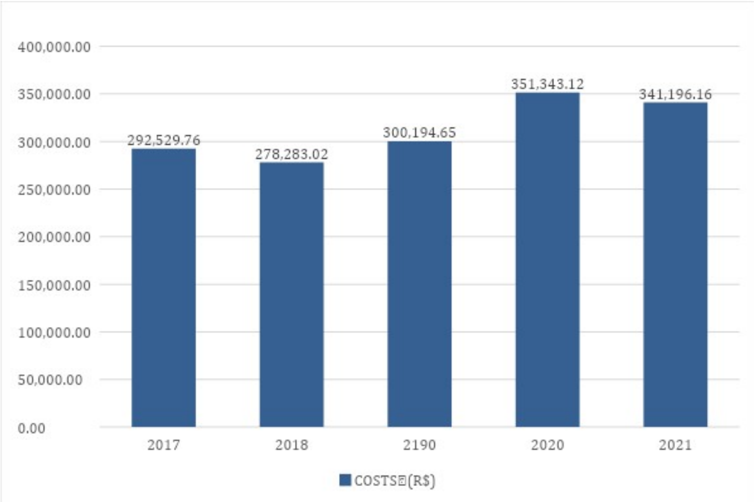

Figure 5: Drinking water and sewage costs at Forum Des. Rodolfo Aureliano.

The second analysis resulted in Table 2, with the result of the monthly water consumption of the building that houses the Forum Des. Rudolph Aureliano.

Table 2: Monthly water consumption at the Forum Des. Rodolfo Aureliano building.

YEAR 2021	
MONTH	**CONSUMPTION (m³)**
January	3.177,00
February	2.957,00
March	2.390,00
April	1.580,00
May	1.579,00
June	2.189,00
July	1.938,00
August	1.754,00
September	2.852,00
October	3.051,00
November	3.822,00
December	2.703,00
TOTAL	**29.992,00**

Source: Prepared by the author, adapted from TJPE (PERNAMBUCO, 2021).

After analyzing the data, it was found that the building of the Forum Desembargador Rodolfo Aureliano, due to the size of the building and the number of people who pass through its environments - around 6,800 users per day - generates a large volume of sewage, around 29,992.00 m³ in 2021, with a monthly average of 2,499 m³, which has great potential for using treated wastewater in its sewage treatment plant.

Still in Table 2, it can be seen that in 2021 there was an annual expenditure of BRL 341,196.16 on drinking water and sewage, which could in part be avoided with water reuse technologies, the objective of this work. Thus, this work, after analyzing the feasibility of reusing wastewater from the ETE, reached the following results.

Environmental Results

According to TJPE data (Table 3), Forum Des. Rodolfo Aureliano is designed to meet the requirements of environmental legislation, after post-treatment of the effluent, for its release into the receiving water body.

Table 3: Effluent characteristics after post-treatment.

Average Daily Flow	280,00 m³/dia
Biochemical Oxygen Demand (BOD)	< 35,00 mg/L
Chemical Oxygen Demand (COD)	< 70,00 mg/L
Thermotolerant Fecal Coliforms (CF)	< 10^2 NMP/100 mL

Source: WESA (2017).

Bearing in mind the study of this research, it was found that the sewage treatment plant analyzed in the Forum Des. Rodolfo Aureliano can bring the reuse of treated wastewater for use in the irrigation of the building green areas, as well as in the cleaning of the external patio, since for this purpose there is a considerable expense of drinking water, for the improvement of irrigation and cleaning of these areas.

Economic Results

Considering that for irrigation of garden areas 5 liters of water are needed for each square meter of area, it appears that for irrigation of the Forum Des. Rodolfo Aureliano garden area, 9,261 m², 46,305 liters of water will be needed. Thus, considering the irrigation activity of two days a week, there would be a monthly consumption of 370,440 liters of water.

Figure 6: Forum Des. Rodolfo Aureliano ETE.

Figure 7: Forum Des. Rodolfo Aureliano 1 garden area.

Thus, considering that the ETE, object of this research, provides a daily volume of 280.00 m³/day (Table 4) of treated effluents and taking into account the analysis of costs with the average consumption of drinking water, in the year of 2021, around R$ 341,000.00 linked to the volumes consumed, it appears that for irrigation of green areas, in an extension of 9,261 m², (Figure 6) we would have savings of 370,440 liters of drinking water per month. Finally, wastewater treated by the ETE brings great economic benefits from non-potable reuse in activities such as garden areas and patio cleaning.

CONCLUSIONS

The development of this work made it possible to evidence the collection of information from the Forum Des. Rodolfo Aureliano Sewage Treatment Plant-ETE, measuring its potential in terms of environmental and economic benefits in the reuse of treated wastewater.

The present study demonstrates that the reuse of water for non-potable purposes in large buildings such as the Forum Desembargador Rodolfo Aureliano, in addition to the contribution to environmental responsibility and the benefits guaranteed by the reduction of water consumption in the supply and minimization of the effluents release in public sanitary sewage systems, it has great economic viability in the rationalization of the consumption of potable water in the event of a water crisis.

This research proved the feasibility of implementing a system of reuse of treated wastewater from the ETE, verifying the possibility of avoiding the waste of 8,400 liters of treated effluents released into the water body. Thus, it was found that the reuse of treated wastewater through the ETE of Forum Des. Rodolfo Aureliano provides a reduction of 370,440 liters in monthly drinking water consumption for garden irrigation activities.

Besides, it appears that the effluents treated through a sewage treatment plant are fundamental in the sustainable logistics plans of water resources, because in addition to contributing to the minimization of the sewage produced, and the relief of public supply systems, it can bring various environmental, economic and social benefits. It is an alternative for the use of water intended for less noble activities, which does not require the use of drinking water for agricultural purposes, landscape irrigation, industrial uses, flushing toilets, washing streets, etc., contributing to the preservation of water resources and bodies. Given this context, the potential for applying research and studies in a sustainable manner aiming at the reuse of wastewater is evident.

Finally, it is necessary to implement new public policies that promote effective actions of sustainable water management practices, especially in public buildings that historically record wasted water, which negatively impacts the environment. Thus, from the results observed in this work, it is clear that the technology of wastewater reuse needs to be disseminated, constituting an important approach for environmental management.

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