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POTENCIAL DE REÚSO DE EFLUENTES TRATADOS PARA IRRIGAÇÃO PERIURBANA NO MUNICÍPIO DE GUARABIRA/PB

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1 RESUMO

A água é um recurso finito que se encontra escasso, o que justifica a busca por gestão e inovação de práticas que a preserve. O objetivo da pesquisa é avaliar o potencial de reúso dos efluentes tratados para irrigação periurbana. Foram levantados dados de uma Estação de Tratamento de Esgotos (ETE), localizada no município de Guarabira, PB, e operada pela Companhia de Água e Esgotos do Estado da Paraíba (CAGEPA), durante o período de janeiro a dezembro de 2019. Analisou-se os seguintes parâmetros físico-químicos e bacteriológicos: Potencial Hidrogeniônico (pH), Condutividade Elétrica (CE), Demanda Bioquímica de Oxigênio (DBO), Demanda Química de Oxigênio (DQO), Sólidos Totais (ST), Oxigênio Dissolvido (OD), Fósforo Total, e Coliformes Termotolerantes. Os dados foram submetidos à análise descritiva e expresso em valores mínimos, máximos e médios. Os indicadores foram satisfatórios para irrigação restrita, porém com a necessidade de tratamento complementar para determinados cultivos. O potencial de reúso dos efluentes tratados na ETE pode beneficiar uma área de 118,7 ha considerando uma demanda de irrigação de 18.000 m³ ha^{-1} ano^{-1}, o que demonstra ser um recurso sustentável e que precisa ser regulamentado no Brasil.

Palavras-chave: recursos hídricos, resíduos líquidos, tratamento de água, fertirrigação.

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2 ABSTRACT

Water is at the center of sustainable development and a finite resource that is in short supply, which justifies the search for management and innovation of practices that preserve it. This research aims to evaluate the potential for reuse of treated effluent for periurban irrigation. Data were collected from a Sewage Treatment Plant (STP), located in the municipality of

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Guarabira, PB, and operated by the Water and Sewage Company of the State of Paraíba (CAGEPA), during the period from January to December 2019, with the analysis of the following physicochemical and bacteriological parameters: Hipogenic Potential (pH), Electrical Conductivity (CE), Biochemical Oxygen Demand (DBO), Chemical Oxygen Demand (DQO), Total Solids (ST), Dissolved Oxygen (OD), Total Phosphorus, and Thermotolerant Coliforms. The data were submitted to the descriptive analysis and expressed as minimum, maximum and average values. The indicators were satisfactory for restricted irrigation, but with the need for complementary treatment for certain crops. The potential for reuse of the effluents treated in the ETE can benefit an area of 118.7 ha considering an irrigation demand of 18,000 m³ ha^{-1} $year^{-1}$, which demonstrates to be a sustainable resource that needs to be regulated in Brazil.

Keywords: Water resources, liquid waste, water treatment, fertigation.

3 INTRODUCTION

The global water crisis, which is also a reality in Brazil across its various regions, has been worsening and is already experiencing one of the worst scarcity scenarios in the last 91 years (CANDAL; SOUZA, 2021). As a result, regions such as the Paraíba semiarid region, which experiences high rainfall deficits ranging from 300 to 800 mm/year, experience social and economic impacts from a lack of water, since this resource is the center of sustainable development and guarantees the survival of family farms (MEDEIROS, 2017).

The proposal for sustainable water management through the reuse of treated effluents is already being used in countries such as Israel, Japan, France, and Spain (SILVA et al., 2018). In Brazil, projects to reuse treated effluents for the agricultural sector are growing. Experiments carried out in Florânia, Rio Grande do Norte (ARAÚJO, 2016), Itapipoca, Ceará (CELEDÔNIO, 2021), and Sertão do Moxotó, Pernambuco (ESTEVES, 2019) are models of effective results, ranging from improved production quality to increased organic matter, which can contribute to the recovery of degraded areas intended for planting. One of the important advantages of reusing these effluents for irrigation is the nutrient supply (nitrogen, phosphorus, and potassium) that it can provide to plants, in addition to protecting the soil and acting as a natural fertilizer (FAO, 2017).

As one of the largest water users in Brazil, irrigation projects that can provide water security to producers while enabling sustainable water management in the preservation of water resources are lacking. In this sense, the objective of this research is to evaluate the potential for reusing effluents treated at the sewage treatment plant (STP) in the municipality of Guarabira for irrigation in peri-urban areas.

4 MATERIALS AND METHODS

The research was carried out from January to December 2019 at the sewage treatment plant (STP) in the municipality of Guarabira, a city located in the semiarid region of the state of Paraíba, with geographic coordinates of 06°57'S and 35°32'W, a territorial area of 162.387 km² and an estimated population of 59,389 inhabitants (IBGE, 2021). The average precipitation in the municipality can reach values slightly above 1000 mm throughout the year.

The ETE is operated by the Paraíba State Water and Sewage Company

(CAGEPA), which aims to reintegrate the treated effluent into the environment, following the standards established by the National Environmental Council (CONAMA) at resolutions 357 and 430. It is formed by a system of two anaerobic lagoons and two facultative lagoons, with the São Salvador Stream, a tributary of the Guarabira River, as the receiving body (Figure 1).

To carry out this work, monthly effluent samples were collected from the raw sewage to the downstream of the receiving body, that is, before and after treatment. The samples were analyzed in the Effluent Analysis and Monitoring Laboratory (LAMEC) of CAGEPA. The parameters analyzed were hydrogen potential (pH), electrical conductivity (EC), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total solids (TS), dissolved oxygen (DO), total phosphorus (P) and thermotolerant coliforms (CTT).

The data were compiled and arranged in electronic spreadsheets and subjected to descriptive analysis, and the values were subsequently expressed as minimum, maximum, and average values. Each physical, chemical, and bacteriological quality parameter was analyzed according to recommendations for reuse in irrigated agriculture, following the guidelines of the Basic Sanitation Research Program (PROSAB) (FLORENCIO et al., 2006).

Figure 1. Guarabira WWTP - PB

Source: Google Maps (2019)

5 RESULTS AND DISCUSSION

The physical-chemical and bacteriological qualities of the effluents treated at the Guarabira ETE are within the standards established by CONAMA at resolutions 357 and 430. The minimum, maximum and average values of the parameters analyzed are shown in Table 1.

Table 1. Minimum, maximum and average values of the analyzed physical-chemical and bacteriological indicators

Values	pH	CE	BOD	COD	OD	P	ST	CTT
		µS cm $^{-1}$	------------------	mg L $^{-1}$	------------------			C/100 mL
Minimum	7.4	1,031.0	57.4	76.9	0.2	5.7	734.0	1.5E+05
Maximums	8.0	1,720.0	116.9	319.1	1.5	7.6	1,165.0	2.4E+06
Medium	7.6	1,455.5	79.9	184.2	0.8	6.7	894.4	6.3E+05

pH: potential of hydrogen, EC: electrical conductivity, BOD: biochemical oxygen demand, COD: chemical oxygen demand, DO: dissolved oxygen, P: total phosphorus, ST: total solids, CTT: thermotolerant coliforms
Source: CAGEPA (2019)

The pH range suitable for irrigation is between 6.5 and 8.4. In addition to this range, there is a risk of nutritional imbalances in plants (FUGITA, 2018). All collected samples fell within this range. Electrical conductivity values between 700 and 3000 µS cm $^{-1}$ are considered in the moderate range, allowing for the irrigation of moderately salt-tolerant plants without the need for specific treatments to control salinity (HOLANDA et al., 2016). Salinity is a concern in irrigated agriculture because it can affect plant growth and cause water stress. Therefore, it is an important factor in determining the suitability of effluent for irrigation (PEREIRA et al., 2024). In all the samples, the electrical conductivity remained within a moderate range, with an average value of 1,455.5 µS cm $^{-1}$.

According to the PROSAB Guidelines for urban and agricultural reuse of treated sewage, there are no restrictions on BOD, COD, or TSS. Effluent concentrations are a consequence of treatment techniques compatible with the stipulated microbiological quality (FLORENCIO, 2006). The BOD and TSS concentrations were above the maximum value for restricted irrigation, which is 30 $^{mg/L,}$ requiring additional treatment to remove organic and inorganic material, as high concentrations of these parameters can cause clogging of the irrigation system (PORTO, 2019). In the case of COD, values must be below 200 mgL^{-1}, except for the January sample, which presented a value of 319.1 mgL^{-1}. The other compounds presented satisfactory values, ranging from 76 to 185 $^{mg/L}$.

The dissolved oxygen content was below the values expected to achieve nitrification, which must be $\geq$ 2.0 mgL $^{-1}$. This result may interfere with the aesthetic quality of the effluent by causing a bad smell but does not make it unviable for irrigation.

Total phosphorus is an important parameter for agriculture because it is an essential nutrient for plant development. The typical concentration range in Brazil is between 5.0 and 20.0 mgL$^{-1,}$ and the values obtained in the analyses are in accordance with this range, which validates the importance of reusing effluents in agriculture with the benefit of having a supply of nutrients that plants and soils need, reducing or eliminating the use of synthetic phosphate fertilizers (BRITO et al, 2014).

According to the PROSAB guidelines, one of the most significant parameters for peri-urban irrigation is thermotolerant coliforms, which must reach values $\leq$ 1000 C/100 mL for unrestricted irrigation. Values above this range, such as those found in the samples, must be considered for restricted irrigation and under the use of additional protection barriers due to the risk of contamination.

The data show that the physical-chemical and bacteriological indicators of the treated effluents are considered satisfactory for restricted irrigation; however, posttreatment is essential not only to satisfy the diversity of crops and systems but also to maintain control of risks due to contaminating agents, as evidenced by the results of the bacteriological parameters (ARAÚJO, 2016).

With respect to reuse potential, the municipality of Guarabira uses 144,000 m³ year $^{-1}$ of potable water in the monitored irrigation areas (ANA, 2021) and has at least 1000 ha of temporary crops (IBGE, 2021), considering an irrigation demand of 18,000 m³ ha $^{-1}$ year $^{-1}$, with a flow rate of 67.39 L s $^{-1}$, which the ETE in operation recorded in 2019, could irrigate, for example, an area of 118.07 ha of green irrigation and landscaping located in squares and leisure areas and preserving the volume of potable water and water reserves that are currently used for this purpose.

In 2019, according to data from the National Sanitation Information System (SNIS, 2019), 2,125.88 m³ of sewage was treated. This volume was discharged into the Guarabira River, with satisfactory collection results upstream and downstream of the receiving body. However, this volume could be channeled and used for urban and peri-urban irrigation, which can be found near the ETE.

6 CONCLUSION

The effluents treated at the Guarabira sewage treatment plant (STP) have the potential to be reused for peri-urban irrigation and contribute to the preservation of water resources. Typical regional crops such as sugarcane, yams, and forage, as well as green irrigation systems in the city's many squares, could utilize this resource and preserve better-quality water for more valuable uses.

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