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Proposal for sustainable technology for sewage treatment in a rural community in Pernambuco – Brazil (Wetlands)

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Highlights:

· Alternative for replacing anaerobic processes, septic tanks, with high methane emissions and low treatment efficiency by constructed Wetlands.

· Alternative sewage treatment technology for a rural community called Crauassu.

· Macrophytes of ornamental species that can be sold and used as a source of income by the community.

Keywords: Rural Communities; Macrophyte; Wastewater Treatment; Constructed Wetlands.

INTRODUCTION

In Brazil, the significant majority of the population of small and medium-sized municipalities that are served by sewage services have their sewage treated by unitary anaerobic processes, septic tanks, with low treatment efficiency (BORATTO et al., 2021).

In this context, constructed wetland systems emerge as an excellent alternative technological for municipalities with populations of less than 15,000 inhabitants (37% of Brazilian municipalities, 35% in the northeast and 22% in Pernambuco) (Figure 1), and thus being favorable for implementation in Pernambuco (Figure 2). Among the various types of constructed wetlands, descending vertical flow systems fed with raw sewage after preliminary treatment (French Model) stand out as a technological alternative for small municipalities, peri-urban centers and isolated urban centers. (BORATTO et al.,2021).

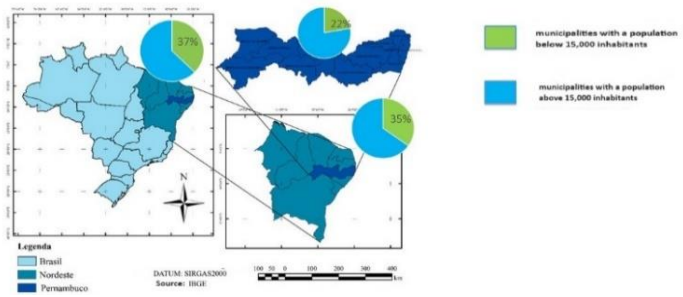

Figure 1: Map presents population by municipality. Source: adapted from Carvalho et al (2017).

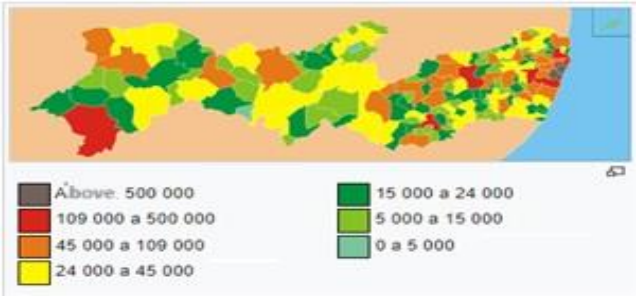

Figure 2: Population estimated for the municipalities of Pernambuco. Source, IBGE (2019).

The present work aims to present wetland technology as an alternative for treating sanitary sewage in rural areas, with advantages in relation to the replacement of unitary systems (septic tanks) and collective systems (septic tank - anaerobic filters, UASB, etc.). Such advantages involve requiring lower implementation and operating costs, reducing methane emissions (greenhouse gas), by eliminating anaerobic processes and enabling the use of macrophytes from ornamental species that can be sold and used as a source of income by the community. The use of wetlands represents an innovation due to the lack of units of this design in operation in the State of Pernambuco, Brazil.

METHODOLOGY

The France model, biological filters, are built in shallow tanks excavated in the ground (1.0 m in depth), waterproofed with a HDPE geomembrane and filled with materials aggregated with granulometries specified in the project with macrophytes planted in the soil (VON SPERLING et al., 2018). This configuration is demonstrated in Figure 3. In the sewage treatment system ornamental plant suggest such as *Heliconia psittacorum* which according to Zanella (2015), is on the list of recommended plants with ornamental potential for use in Wetlands built in Brazil. The location chosen for study was the rural community of Crauassu, UTM coordinates 267,751E and 9,071,513N.

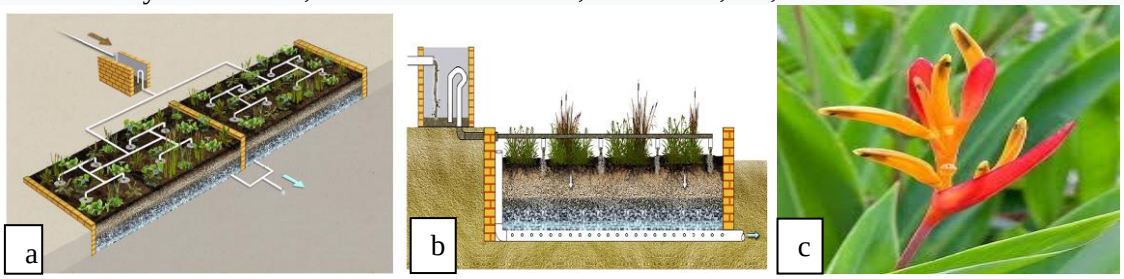

Figure 3: Scheme of a vertical wetland - French system adapted to hot regions:. Source: a and b - Ferraz and Faria (2020); *Heliconia psittacorum.Source: c-Zanella (2015)*

RESULTS AND CONCLUSIONS

According to the project parameters (in Table 1), the planned investment for implementing the sewage system at the Crauassu Plant is U$ 100,000 with an estimated flow of 30 m³/d. Table 2 presents the implementation and operating costs (US$/inhabitant) and average quality of the treated effluent comparing different treatment technologies.

Table 1: Parameters and service requirements for the sewage treatment plant in Crauassu.

Project Features	Normative standard
Population served: 400 inhabitants Receiving body: Ipojuca River Technology: French Wetland Approximate flow: 30 m³/d Raw sewage BOD: 600 mg/L	Minimum removal efficiency of 90% or final effluent presenting BOD below 60 mg/L and thermotolerant coliforms below 1000 MPN/100mL (Normative Instruction CPRH Nº03/2018)

Table 2: Characteristics of sewage treatment systems.

Treatment System	Estimated Implantation Costs (U$/inhab.)*	Estimated Operating and Maintenance Costs (U$/inhab.year)*	Average Quality-DBO_5(mg/L) **	Average Quality-Thermotolerantes Coliforms (NMP/100mL)**
Anaerobics lagoons-optional lagoon	19,82 – 30,90	1,27 - 2,18	50-80	10^6 -10^7
Septic tank –anaerobic filters	35,27 – 66,0	2,73 - 4,36	40-80	10^6 -10^7
Wetlands	22 - 44	1,10 – 2,18	30-70	10^4 -10^5
UASB reactor	8,73 – 26,3	1,27 – 2,18	70-100	10^6 -10^7

Source: Adapted Von Sperling (2014 *, 2006**).

It is observed that the implementation and operating costs for Wetlands are lower than those for stabilization ponds, septic tanks, anaerobic filters, and UASB reactors, achieving a higher average quality of the treated effluent.

To reduce the cost of acquiring the macrophyte, the use of a predominant local species, Heliconia psittacorum, was considered since in addition to the good efficiency reported in constructed wetlands, has great economic value in the market, at a global level. It is estimated that commercial production of heliconias is around U$ 21.000,000 (KONNERUPP; OOTTATEP; BRIX, 2009; HERNÁNDEZ, 2004).

Treated effluents from wetlands, as they have superior physical and chemical quality compared to other anaerobic treatments, can be reused to irrigate forage crops to feed animals (goats, sheep, pigs, cattle), minimizing the use of water resources, as shown in Table 1. They can also achieve a microbiological standard (*E.Coli*<10^5/100mL) that allows irrigation for types of crops with unrestricted irrigation category (WHO, 2006a).

The present study demonstrates that, besides the technical and economic advantages, the inclusion of constructed Wetlands in the treatment of sanitary sewage for rural communities can reduce relevant environmental impacts. This is because, septic tanks, the main unitary sewage treatment technology used by rural communities, have low treatment efficiency and methane emissions up to 80 times higher than constructed wetlands. In the scenario of universalization of sanitation, the incorporation of constructed wetlands into the matrix of treatment technologies in Brazil proves to be a viable alternative, guaranteeing compliance with the goals of universalization regarding sewage treatment and being a source of subsistence for the community through plant management as a possibility of income.

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