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Capital expenditure analysis for sanitation applied to small Brazilian municipalities

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Highlights:

- 64% of Brazilian municipalities have an urban population <10,000 inhabitants and face difficulties in implementing conventional sewage collection and treatment.
- The sanitation model based on the management of treatment systems at the lot level should be considered for universalization.
- The average CAPEX of the two sanitation models was estimated for all Brazilian municipalities <10,000 inhabitants, by region.

Keywords: fecal sludge management; septic tank; universalization of sanitation.

INTRODUCTION

The discussion about economic and financial feasibility becomes even more relevant when considering the served populations. Small municipalities with low population densities face difficulties in implementing conventional sanitation systems (sewage network and centralized treatment). In Brazil, according to Brazilian Institute of Geography and Statistics, 64% of the municipalities have an urban population less than 10 thousand inhabitants, 20% have a population between 10 and 25 thousand inhabitants, 7% between 25 and 50 thousand; 4% between 50 and 100 thousand, 4% between 100 and 500 thousand, and just 1% have a population greater than 500 thousand inhabitants (IBGE, 2012).

In this context, it is necessary to consider new concepts or models of sanitation that improve public health and environmental quality of watersheds, and that enable the project payback to modest investments. Thus, an integrated approach to managing onsite sanitation systems can become a promising model for small municipalities. The model is based on the controlled and periodic removal, and subsequent treatment of by-products from septic tanks and similar systems (sludge, scum, and grease), through vacuum trucks, which should be managed by a third party (public or outsourced company).

This study aims to present an overview of the capital expenditure (CAPEX) for the modal with scheduled emptying of onsite sewage treatment systems, in comparison with sewer network and centralized wastewater treatment, applied to Brazilian municipalities with urban populations of less than 10 thousand inhabitants.

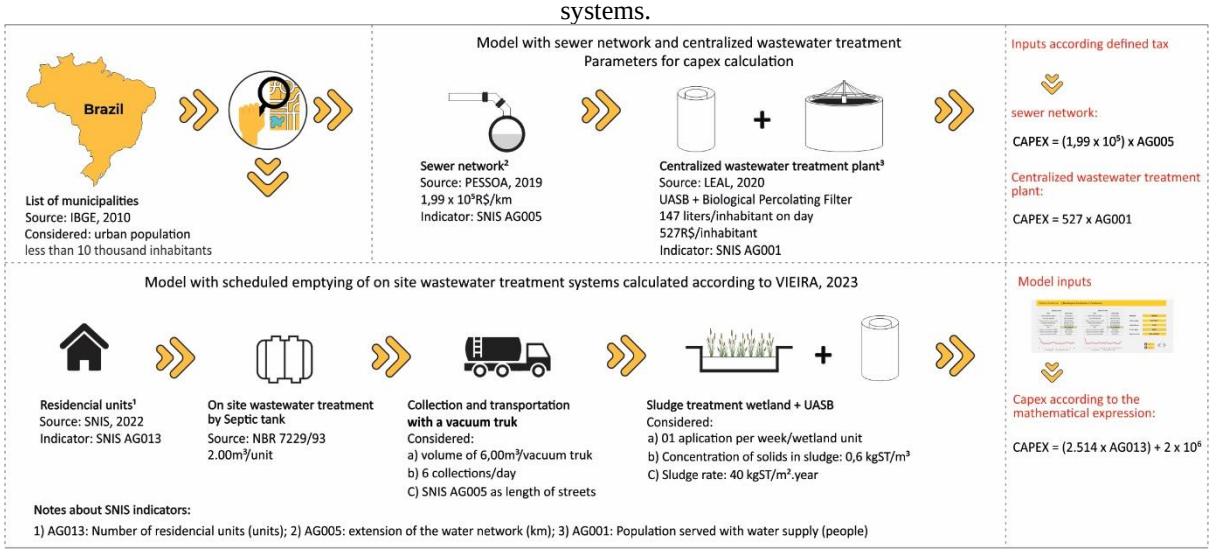
METHODOLOGY

The Brazilian municipalities with urban populations below 10 thousand inhabitants were identified. The IBGE database used refers to the 2010 census. Subsequently, indicators from the National Sanitation Information System (SNIS) were selected for use in the CAPEX modeling considering the year 2023. The CAPEX was identified for the sewerage and onsite sanitation models using three SNIS indicators: AG001 (population served with water supply), AG005 (water network extension), and AG013 (number of water connections).

For the model with centralized sewage collection and treatment, we considered a sewer network with a diameter of 150mm, and an up-flow anaerobic sludge blanket (UASB) followed by a biological percolating filter for the wastewater treatment. The CAPEX calculation used the rates found by LEAL; ABE; DOMINGUES (2020) for the sewage collection network, and PESSOA (2019) for the wastewater treatment plant. As a simplification, the extension of the water network was considered equal to the extension of the sewer network.

The model with scheduled emptying of onsite systems considered the existence of septic tanks with a volume of 2.00m³ in a standard situation of 4 inhabitants per household, emptied once a year by a vacuum truck that removes the entire volume (called here as fecal sludge). The fecal sludge goes to a treatment plant, composed of a sludge treatment wetland for dewatering and mineralization and a UASB for the treatment of the drainage effluent. The CAPEX calculation for this system considered the formulations established by VIEIRA (2023) for the context of municipalities operating autonomously with onerous investments (Figure 1).

Figure 1 - Methodology for calculating the comparative CAPEX between the model with sewer network and centralized wastewater treatment and the model with scheduled cleaning of on site wastewater treatment systems.



RESULTS AND CONCLUSIONS

The results shown in Table 1 indicate that the model with onsite treatment and scheduled emptying of fecal sludge has a CAPEX value 44% lower than the model with sewer network and centralized wastewater treatment, resulting in savings of around $3.32 billion for achieving universalization in the studied population stratum.

Table 1 - Comparative CAPEX Value between Modalities (values in USD)

Federal Unit	Model with sewer network and centralized sewage treatment	Model with scheduled cleaning and on-site sewage treatment	Saved Value
North	0,40 Bi	**0,22 Bi**	0,18 Bi
Northeast	2,55 Bi	1,44 Bi	1,11 Bi
Southeast	2,21 Bi	1,25 Bi	0,96 Bi
Midwest	0,73 Bi	0,39 Bi	0,34 Bi
South	1,68 Bi	0,95 Bi	0,73 Bi
TOTAL COST	**$7,57 Bi**	**$4,25 Bi**	**$3,32 Bi**

Beyond the associated savings, it is necessary to consider the need for new sanitation service chains, including the valorization of treated sludge. The resource recovery of sludge can lead to even more attractive projects. Additionally, small municipalities can avoid common problems faced when implementing conventional systems, such as soil quality issues for network installation, excessive mechanization with sewage lift stations, high energy costs, more complex wastewater treatment plants, specialized personnel, and the need for substantial reinvestment in future infrastructure replacement.

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