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COMPARATIVE MANAGEMENT OF SEWAGE COLLECTION AND TREATMENT SYSTEMS WITH AIM FOR UNIVERSALIZATION AND SUSTAINABILITY¨

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Abstract: Basic sanitation has been present throughout the evolution of the human species. For several periods there was neglect of this important service, and as a consequence, it was always followed by major epidemics and high mortality rates. Finally, a direct relationship between the quality of sanitation and the emergence of epidemics had been demonstrated, having as its cause the low quality of the sewage service and, as a consequence, the appearance of contagious diseases with a high number of deaths. In this sense, advancement and improvement in meeting desirable levels of collection, treatment and sanitation in general is highlighted as a primary need. The objective of this article is to demonstrate the installation and operation costs involved when adopting collective operation of sewage collection and treatment systems, whether individual or collective systems, and to present a comparative analysis for the application of each type of system. The methodology involved sought to survey several sanitations works in the southern region of Brazil, involving the states of Rio Grande do Sul, Santa Catarina and Paraná, with works between the years 2013 and 2021 for a collective sewage collection and treatment system. and a survey of the costs of building and implementing individual solutions. This seeks the possibility of improvements in the management of the public service with regard to its indicators, bringing advances in the expansion of systems, an increase in sanitation levels with a view to universalization and sustainability.

Keywords: Sanitation; Basic sanitation; Sustainability; Universalization, Sanitation Management.

INTRODUCTION

According to the definition of the World Health Organization – WHO (2019), "health is the state of complete physical, mental and social well-being, not merely meaning the absence of disease", not being an isolated phenomenon, but rather the result of the conditions of surroundings where the population lives.

The relationship between Water Supply Systems and Sanitary Sewage Systems is very close due to the fact that the second is the residue or by-product of the first. Therefore, in communities served by water supply networks and lacking a sewage system, wastewater ends up contaminating the soil, surface water and groundwater, often flowing through ditches and gutters, constituting a strong point of creation, proliferation and dissemination of diseases and their transmitting vectors.

Sewage is considered the biggest problem related to basic sanitation in the world and it is no different in Brazil (ITB, 2019), it is the main concern and object of this study, focusing on more economical systems for sewage collection and treatment.

The need and importance of basic sanitation to ensure the dignity of the human person and for social, economic and environmental development is very clear and understood. The difficulty of applying economic-financial criteria in an ideal system directs efforts towards alternative solutions, inevitably in the medium and short term, to accelerate the path towards the universalization of basic sanitation – sewage.

In this sense, the topic of basic sanitation, and especially sanitation, has a very broad relevance for society, although not perceived and prioritized by many (IBOPE/ITB, 2012).

According to the UN (2019), for each unit of value used in basic sanitation, savings of four times that same unit in health are obtained. In the environmental context, contamination of surface and underground waters and soil occurs directly. Inadequate management favors the emergence and proliferation of disease-transmitting vectors.

Figure 1 shows the relationship between sewage collection and treatment rates and the HDI of each economic block analyzed, thus highlighting their closely linked correlation (UNICEF; WHO, 2019).

According to Barros (2019), during the history of sanitation in Brazil there were factors that hindered its progress over the years. He also cites some obstacles that prevented, and still prevent, the development of this area from achieving significant growth during this period, they are:

- Lack of adequate planning;
- Insufficient volume of investments;
- Deficiency in the management of companies providing sanitation services;
- The low technical quality of the projects and the difficulty in obtaining financing and licenses for the works.

Meeting the goals established in the National Sanitation Plan, the 2030 Agenda and Law No. 14,026/2020 requires special attention and a large volume of resources, assertive application, well-designed projects and adequate execution (CNI, 2019). The results of meeting these goals will have a positive impact on the search for sustainability, with actions in the social, economic and environmental axes.

The scope of the study involves collecting information on the installation and implementation costs of each type of system in the southern region of Brazil between the years 2013 and 2021, as well as presenting the operating costs from the user's point of view.

According to the historical series (SNIS, 2011–2021) of investment in basic sanitation in Brazil, the values are around R$15 billion. With the advent of the New Sanitation Framework, Law 14026/2020, and sector estimates, there will be a need to invest ~R$700 billion by 2033, that is, 5 times the amount historically invested in Basil. On the other hand, barriers such as trained professionals, industry supply capacity - inputs, availability of parts and equipment, compliance with legislation, among others, are limiting factors in achieving universalization goals.

OBJECTIVES

The objective of this work was to determine the costs for implementing collective sewage collection and treatment systems, discuss and compare alternatives between them that can provide economic viability and achieve the expectations of governments, sanitation companies and society in general regarding meeting the levels coverage desired.

METHODOLOGY

The methodology developed in this work is based on the characterization of the different types of sewage collection, transport and treatment systems, surveying their costs and providing subsidies for their applications. The systems were characterized through constructive aspects, collection and treatment methods. The environmental sphere will be considered met regardless of the alternative adopted, as both systems have the capacity to treat and meet the environmental parameters of effluents. The social aspect will also be taken into account when local sewage is being collected and treated, regardless of the system to be adopted. Considering the triad of economy, society and environment, the focus of this work is to attribute the economic-financial viability relationship of each system.

According to Tsutiya and Sobrinho (2011), the situation of disposal of the populations' excreta was making it difficult at the same rate as the population growth of the communities, especially in England and on the European continent. As a result, toilets were developed that had the function of storing accumulated excreta, however, this alternative generated many problems, such as undesirable odors, the way of collecting and disposing of excreta

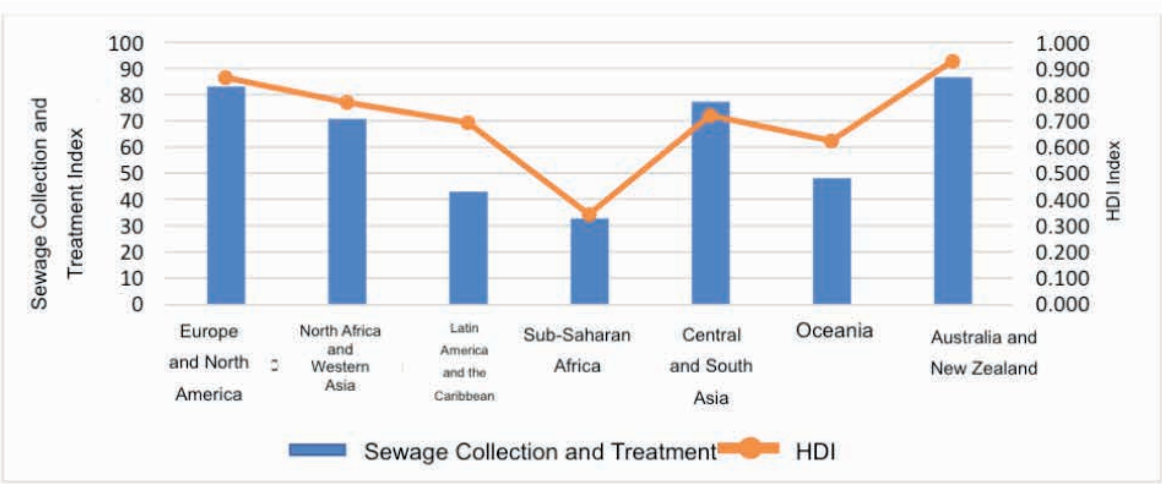

Figure 1: Sewage Collection and Treatment correlation x HDI in economic blocks around the world. Based on UNICEF and WHO, 2019.

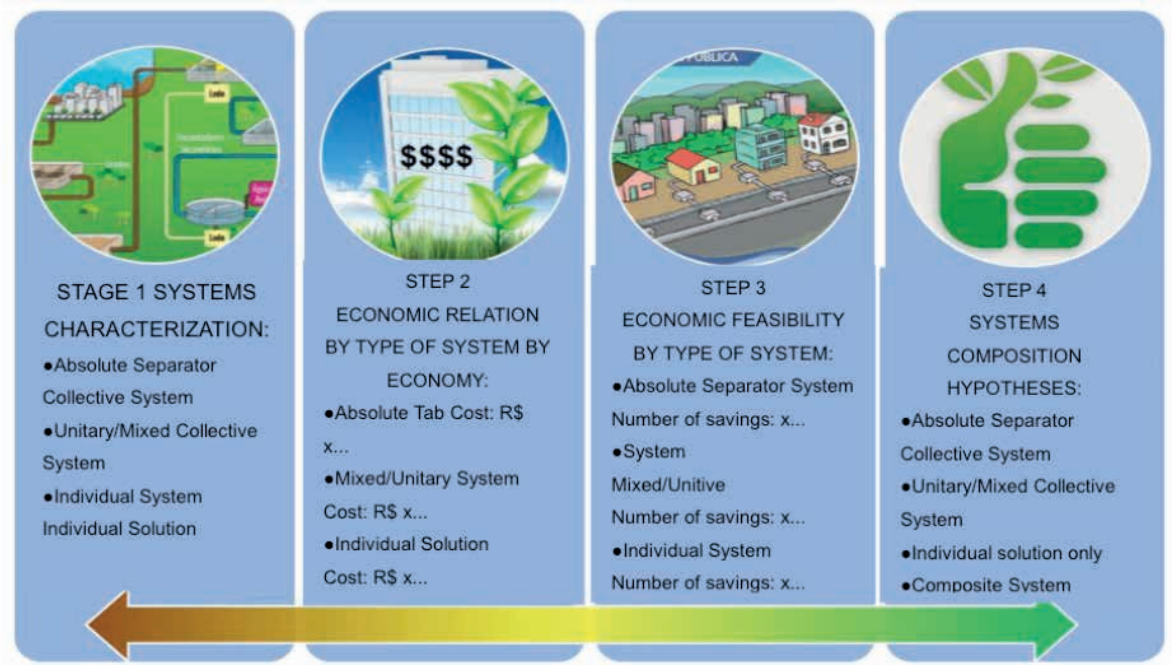

Figure 2: Flowchart of the methodological procedure.

accumulated in toilets.

According to Metcalf and Eddy (2003), only in the 19th and early 20th centuries did authorities begin to place greater emphasis on the collection and disposal of domestic sewage, mainly due to problems with sewage disposal, strong odors and the occurrence of epidemics.

According to Nuvolari (2011), with the implementation of the absolute separator system, with lower costs and smaller works, it was possible to advance in solving the problem of lack of sanitation in cities. However, the absolute separator system, due to poor use by its users, presented several problems, such as: obstruction and overflow of the piping at the opening points, due to the release of dirt into the system, overflow and reflux in the piping and water connections. rainwater and/or drainage in this system, among other problems.

Decentralized systems tend to be seen as synonymous with precariousness and underdevelopment, being considered inferior to other solutions available for large urban centers. However, any system provided for in technical standards or with proven efficiency can be considered as an adequate solution in social and environmental. This way, the decentralization strategy is increasingly complementary and not opposed to the centralization of sewage treatment in the search for the universalization of sewage services (Libralato et al, 2012).

Decentralized systems are in demand for alternative solutions and are gaining more and more attention because they present several benefits, which are widely discussed in the literature and in this work, such as the demand for less financial resources during implementation (sometimes), the contribution to local sustainability (Metcalf & Eddy, 2003) and the opportunity to reuse water and nutrients at the treatment site (Gikas & Tchoubannouglous, 2008). Other advantages stand out for these types of systems, such as the low installation and operation cost, adaptability to each location, in addition to considering possible cultural requirements that must be adapted, they are more compact systems and are not influenced by disasters. natural, do not require specialized labor, in short, they are more flexible systems with greater practicality in terms of implementation, execution, operation and maintenance, with equal social and environmental benefits (Bueno, 2017).

COLLECTIVE SYSTEMS

Among the types of collective sewage collection and treatment systems, the absolute separator type, the unitary system and the mixed system stand out. The differences between these three types of systems refer to the liquid transported, with the absolute separator being characterized by collecting exclusively sanitary sewage, and the unitary and mixed systems by being shared with rainwater.

The absolute separator type sanitary sewage system, according to Brazilian standard ABNT-NBR 9.648 (ABNT, 1986), is the "set of conduits, installations and equipment intended to collect, transport, condition and route only sanitary sewage at one disposal convenient, continuous and hygienically safe end". Figure 4 presents graphically and schematically how this type of system works.

The unitary sewage collection, transport and treatment system (Figure 5) is characterized by conveying wastewater or sewage, infiltration water and rainwater in a single network (TSUTIYA, BUENO, 2004). This system contains a certain flow rate for treatment, which, when exceeded, drains directly to the receiving body all the volume above that sized through the "by pass" of the collection system. These elements are

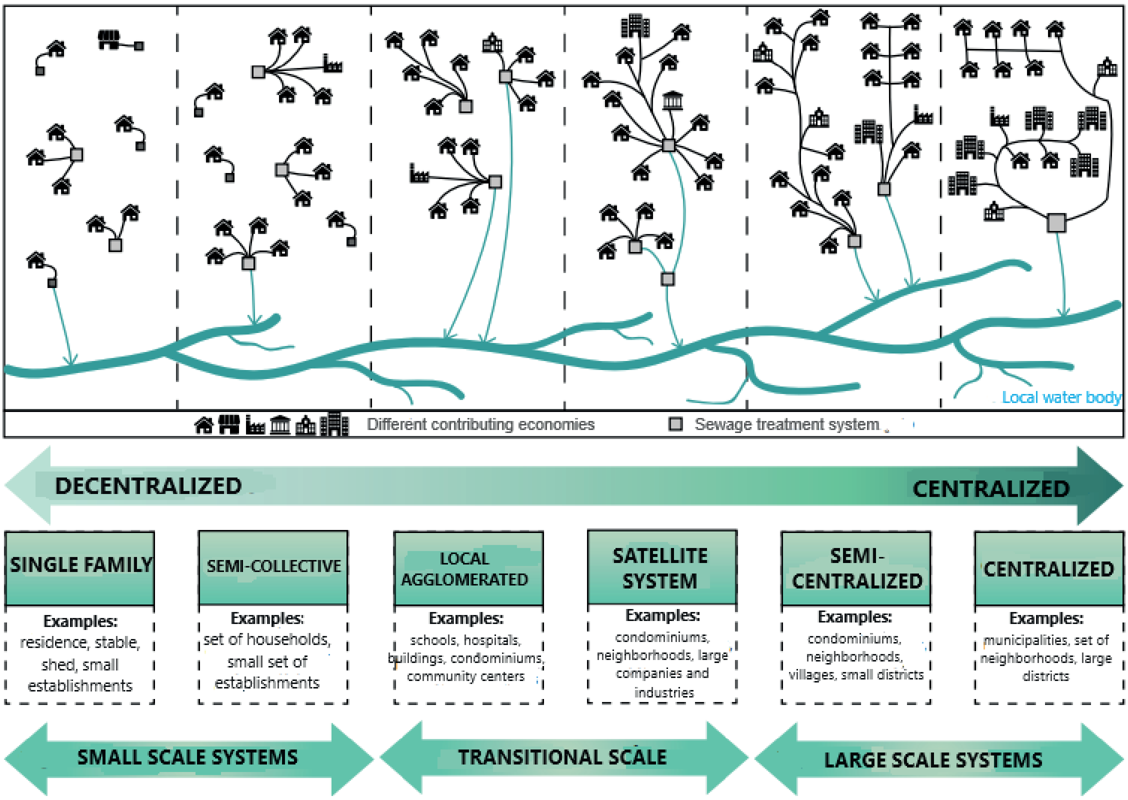

Figure 3: Sewage collection and treatment system gradient, related to whether it is centralized or decentralized. Source: Tonetti, 2018, adapted from Bueno, 2017.

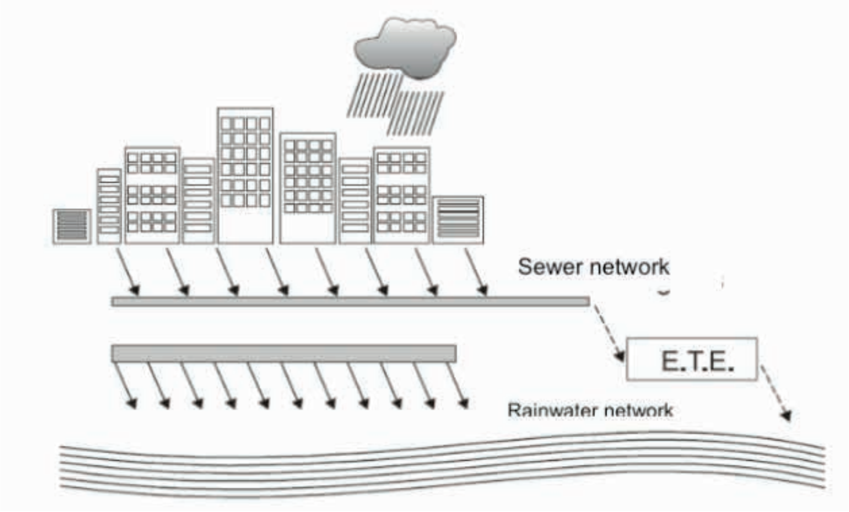

Figure 4: Example of Absolute Sewage Sewerage System. Source: Adapted from Tsutiya; Bueno, 2004.

intended to redirect the excess flow with a lower polluting load to bypass the ETE, thus optimizing the treatment capacity, flow and sizing of the infrastructure.

According to findings by Ide (1984), the effect of the washing load was observed for these events, with the first 10% of the total flow drained concentrating 90% of the pollutant load. The study also noted that at the end of the event the concentration of COD (chemical oxygen demand) represented only 1.66% of the peak reached in this same event, thus justifying the "by pass" function in the system after the first moments of flow of the effluent and eliminating its excess in the ETE.

The mixed system, as represented in Figure 6, considers the portion of rainwater, coming from the roofs of residences and their respective patios, drained together with the sewage produced there, carried by a single network to the ETE. It is observed that there are two networks in this system, one for collecting sewage and a portion of rainwater and the other exclusively for draining rainwater, like the absolute separator system (Tsutiya & Bueno, 2004).

INDIVIDUAL SYSTEM

These are systems adopted for single-family services where each house has its own system for collecting, removing and treating domestic sewage. Therefore, it consists of releasing domestic sewage generated in a housing unit, usually in a septic tank, where there is action of anaerobic bacteria, with a subsequent filtration device and the last stage called a sink, with infiltration into the soil or arranged in a waste collection network. rainwater, as shown in Figure 7.

Individual sewage treatment systems have a very large range. It is noteworthy that inadequate or non-existent management of individual systems causes collapse in their treatment process due to accumulation of sludge and internal saturation, therefore, treatment is no longer carried out. So important for this system is compliance with the maintenance and sludge collection regime from its devices, which will guarantee the normal functioning of the system.

Defining the condition or situation found in each system is an important point for decision making and identifying workaround alternatives. Figure 8 presents a flowchart to help identify which solution is being applied in each system.

According to the flowchart in Figure 8, the lack of sanitary sewage and rainwater drainage systems characterizes the total absence of sanitary infrastructure and the need for comprehensive planning in this location, generally characteristic of poorer regions or located in riverside or peripheral locations. On the other hand, checking the sewage system through the absolute separator system demonstrates more adequate service from a technical point of view in Brazil.

In cases where there is infrastructure based on individual solutions, the flowchart in Figure 9 points to an alternative to maintaining it or choosing a more appropriate collective system that meets local health needs.

RESULTS AND DISCUSSIONS

According to the researched literature and field data collected, the costs of implementing SES's have a different distribution according to each component part of the system, when considering collective systems and especially the absolute separator system. Figure 10 presents the percentage contribution to implementation costs for each constituent part of the system.

With this information, it is possible to quantify the costs due to savings of some systems, based on data from contracting works for the construction of sewage networks, ETE's, lifts, in short, each part that makes up

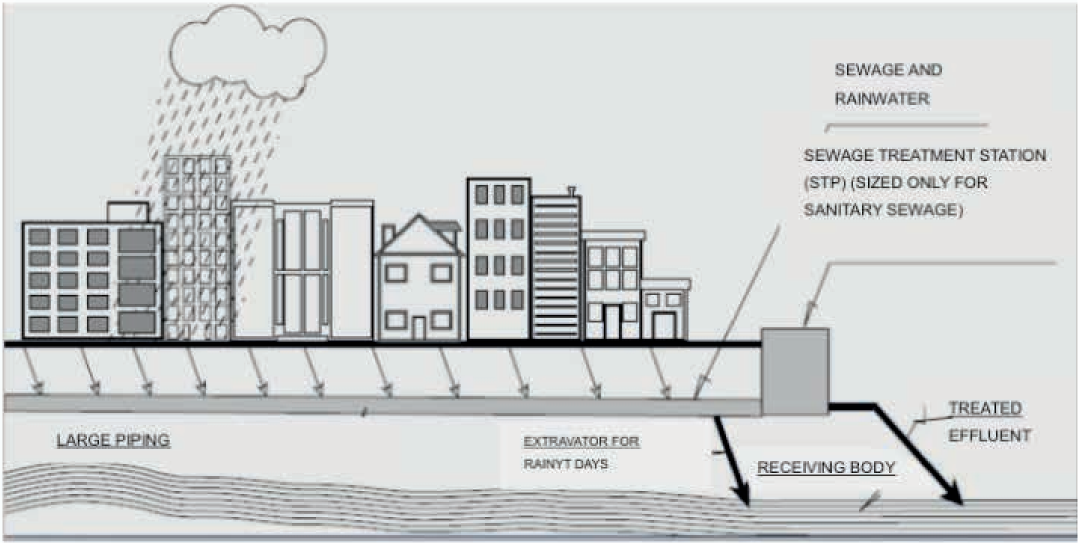

Figure 5: Example of a Unitary Sanitary Sewage System. Adapted from Tsutiya; Bueno, 2004.

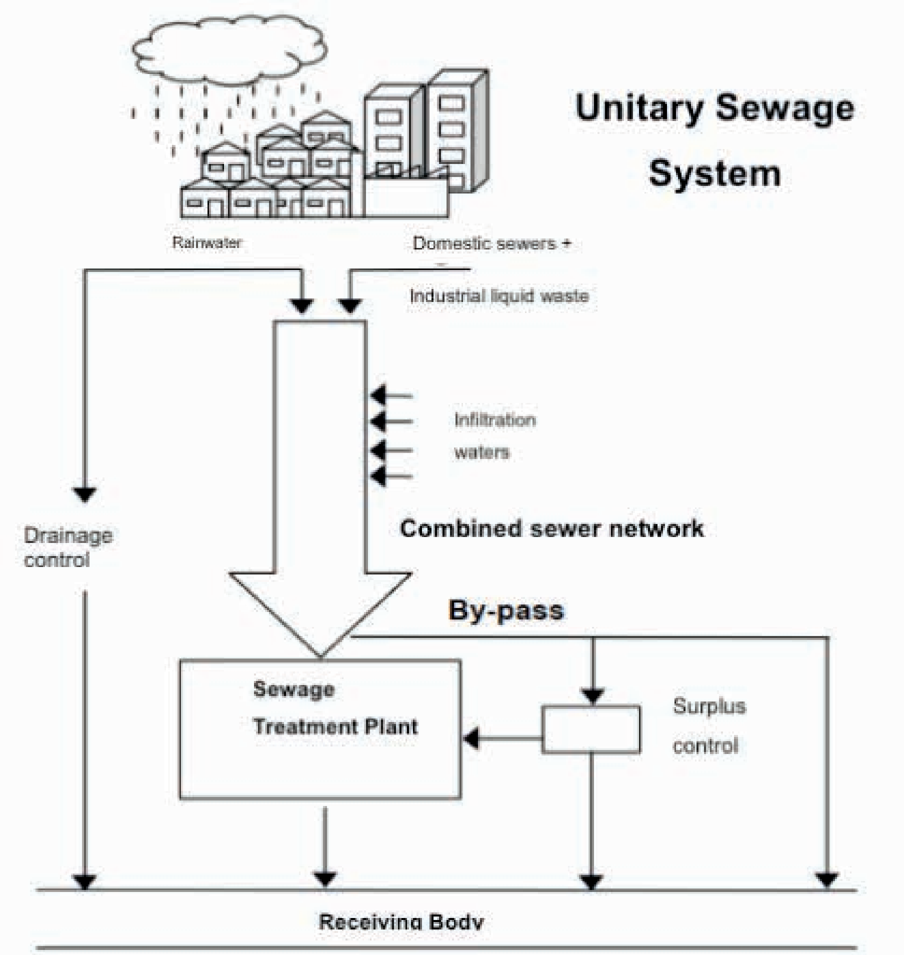

Figure 6: Example of Mixed Sanitary Sewage System. Source: Adapted from Bernardes, 2013.

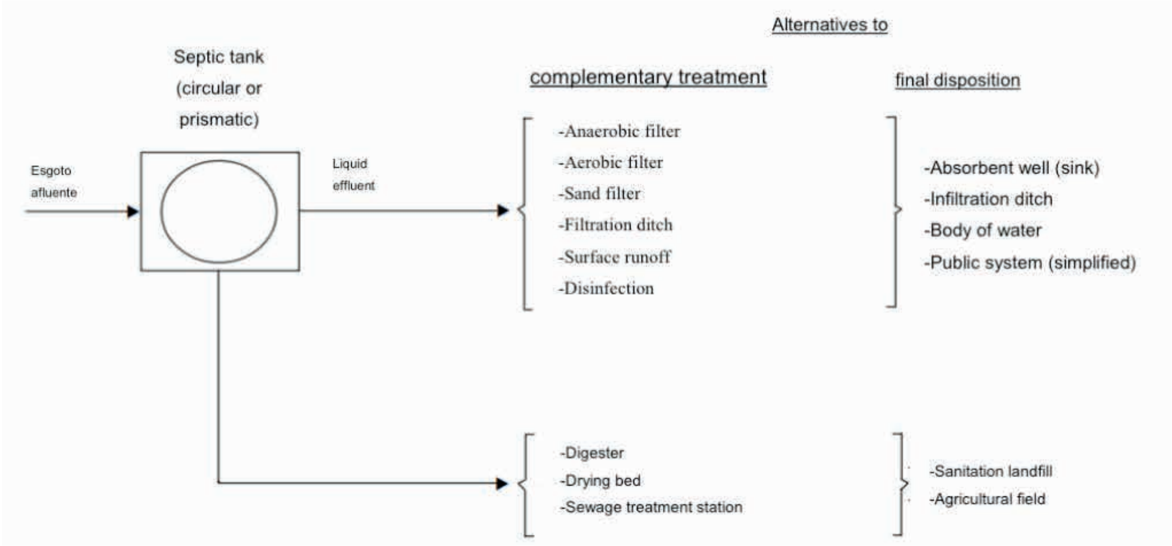

Figure 7: Flowchart of Individual Sanitary Sewage Treatment System. Adapted ABNT NBR 7229-1993.

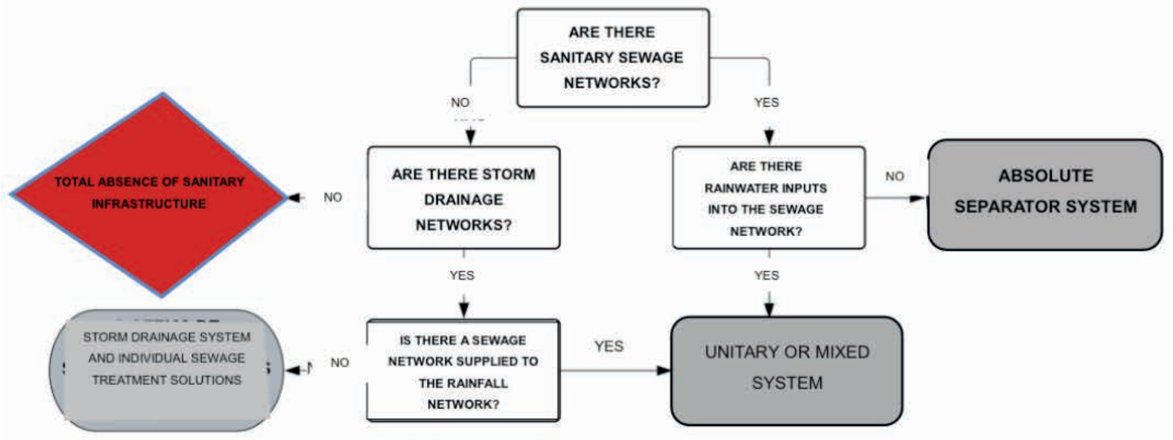

Figure 8: Flowchart of conditional design and identification of the type of system or solution. Adapted from BERNARDES; SOARES, 2004.

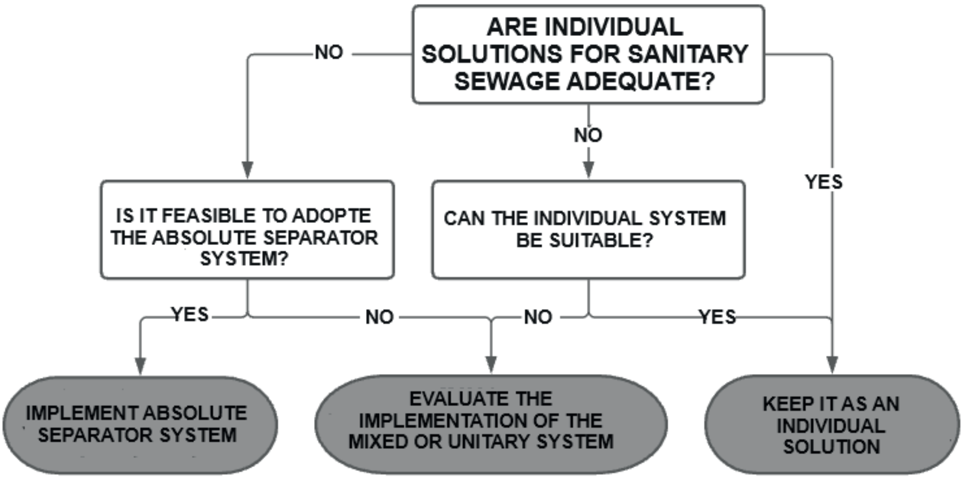

Figure 9: Management alternatives for implementing a sewage system. Adapted from BERNARDES; SOARES, 2004.

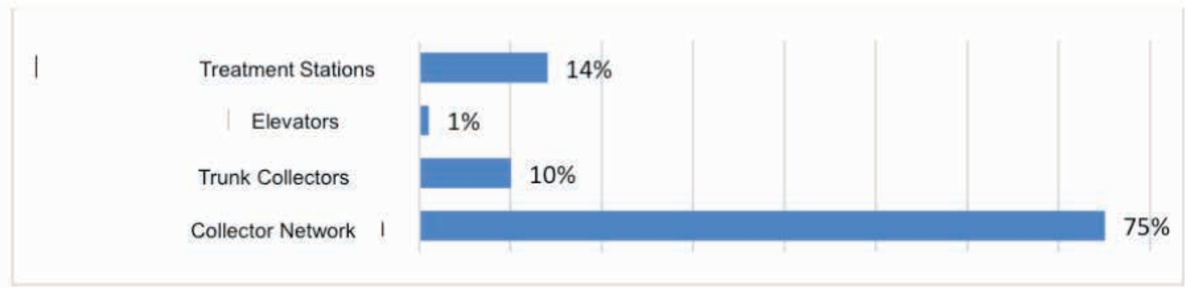

Figure 10: Percentage of cost by system - collective type.

YEAR	COMPANY	*UPDATED VALUE	ECONOMIES	PARTIAL COST ECONOMY	% to be applied	COST PER REAL SAVINGS
2020	CORSAN	R$ 1.898.530,51	1.110	R$ 1.710,39	75	R$ 2.280,52
2020	CORSAN	R$ 19.249.767,63	129.487	R$ 148,66	1	R$ 14.866,18
2019	CORSAN	R$ 19.437.100,83	15.870	R$ 1.224,77	14	R$ 8.748,36
2018	CORSAN	R$ 2.254.367,78	270	R$ 8.349,51	75	R$ 11.132,68
2018	CORSAN	R$ 2.408.080,42	500	R$ 4.816,16	75	R$ 6.421,55
2018	CORSAN	R$ 44.679.316,44	101.499	R$ 440,19	14	R$ 3.144,25
2018	CORSAN	R$ 28.943.074,49	4.531	R$ 6.387,79	75	R$ 8.517,05
2013	PAC	R$ 3.119.292,40	1.723	R$ 1.810,38	14	R$ 12.931,32
2019	CORSAN	R$ 39.442.143,80	6.395	R$ 6.167,65	75	R$ 8.223,54
2018	CORSAN	R$ 26.596.800,06	2.260	R$ 11.768,50	75	R$ 15.691,33
2017	CORSAN	R$ 20.800.663,02	30.000	R$ 693,36	14	R$ 4.952,54
2019	CORSAN	R$ 36.577.955,34	10.000	R$ 3.657,80	76	R$ 4.812,89
2016	CORSAN	R$ 9.531.791,49	998	R$ 9.550,89	76	R$ 12.566,96
2016	CORSAN	R$ 38.299.305,68	10.000	R$ 3.829,93	75	R$ 5.106,57
2018	CORSAN	R$ 7.911.448,17	15.000	R$ 527,43	15	R$ 3.516,20
2018	CORSAN	R$ 19.538.747,72	2.928	R$ 6.673,07	76	R$ 8.780,35
2019	CORSAN	R$ 29.866.059,15	3.472	R$ 8.601,98	76	R$ 11.318,39
2013	CORSAN	R$ 1.170.835,43	215	R$ 5.445,75	75	R$ 7.260,99
2016	CORSAN	R$ 28.015.945,71	30.000	R$ 933,86	14	R$ 6.670,46
2017	CORSAN	R$ 981.574,34	88	R$ 11.154,25	76	R$ 14.676,65
2017	CORSAN	R$ 6.410.461,56	450	R$ 14.245,47	75	R$ 18.993,96
2017	CORSAN	R$ 9.684.522,10	6.400	R$ 1.513,21	15	R$ 10.088,04
2019	CASAN	R$ 197.150.875,18	45.000	R$ 4.381,13	89	R$ 4.922,62
2021	CASAN	R$ 74.358.440,00	10.000	R$ 7.435,84	100	R$ 7.435,84
2020	CASAN	R$ 21.107.200,00	2.400	R$ 8.794,67	76	R$ 11.571,93
2018	CASAN	R$ 28.397.670,00	2.030	R$ 13.989,00	76	R$ 18.406,58
2016	CASAN	R$ 59.044.320,00	3.547	R$ 16.646,27	89	R$ 18.703,67
2014	CASAN	R$ 72.454.800,00	4.942	R$ 14.661,03	75	R$ 19.548,04
2016	CASAN	R$ 22.986.720,00	1.133	R$ 20.288,37	76	R$ 26.695,22
2018	CASAN	R$ 32.874.150,00	2.500	R$ 13.149,66	100	R$ 13.149,66
2015	CASAN	R$ 15.457.540,00	2.000	R$ 7.728,77	89	R$ 8.684,01
2015	CASAN	R$ 41.956.180,00	2.225	R$ 18.856,71	100	R$ 18.856,71
2016	CASAN	R$ 84.134.400,00	7.100	R$ 11.849,92	100	R$ 11.849,92
2016	CASAN	R$ 65.654.880,00	10.600	R$ 6.193,86	100	R$ 6.193,86
2016	CASAN	R$ 60.847.200,00	6.443	R$ 9.443,92	100	R$ 9.443,92
2020	CASAN	R$ 25.196.720,00	2.425	R$ 10.390,40	100	R$ 10.390,40

2015	CASAN	R$ 21.924.470,00	1.925	R$ 11.389,34	100	R$ 11.389,34
2015	CASAN	R$ 44.479.860,00	1.750	R$ 25.417,06	100	R$ 25.417,06
2016	CASAN	R$ 94.350.720,00	11.500	R$ 8.204,41	100	R$ 8.204,41
2020	CASAN	R$ 27.307.932,79	2.250	R$ 12.136,86	100	R$ 12.136,86
2014	CASAN	R$ 23.053.800,00	2.000	R$ 11.526,90	100	R$ 11.526,90
2014	CASAN	R$ 26.826.389,70	7.750	R$ 3.461,47	76	R$ 4.554,57
2015	CASAN	R$ 82.034.376,95	5.276	R$ 15.548,59	100	R$ 15.548,59
2018	CASAN	R$ 29.516.790,00	1.500	R$ 19.677,86	100	R$ 19.677,86
2019	CASAN	R$ 114.290.400,00	5.000	R$ 22.858,08	100	R$ 22.858,08
2019	CASAN	R$ 63.673.422,75	4.386	R$ 14.517,42	100	R$ 14.517,42
2020	CASAN	R$ 13.192.000,00	1.300	R$ 10.147,69	100	R$ 10.147,69
2021	SANEPAR	R$ 45.920.030,00	5.800	R$ 7.917,25	100	R$ 7.917,25
2021	SANEPAR	R$ 6.771.050,00	2.100	R$ 3.224,31	75	R$ 4.299,08
2021	SANEPAR	R$ 1.723.540,00	412	R$ 4.183,35	100	R$ 4.183,35
2021	SANEPAR	R$ 36.933.000,00	3.200	R$ 11.541,56	89	R$ 12.968,05
2020	SANEPAR	R$ 10.553.600,00	580	R$ 18.195,86	100	R$ 18.195,86
2020	SANEPAR	R$ 7.255.600,00	481	R$ 15.084,41	100	R$ 15.084,41
2020	SANEPAR	R$ 26.384.000,00	2.100	R$ 12.563,81	100	R$ 12.563,81
2020	SANEPAR	R$ 923.440,00	415	R$ 2.225,16	75	R$ 2.966,88
2015	FUNASA	R$ 10.924.102,35	700	R$ 15.605,86	100	R$ 15.605,86

Note: *Values updated according to INCC – FGV/IBRE for 01/2023.

Table 1: Base data for determining costs per unit.

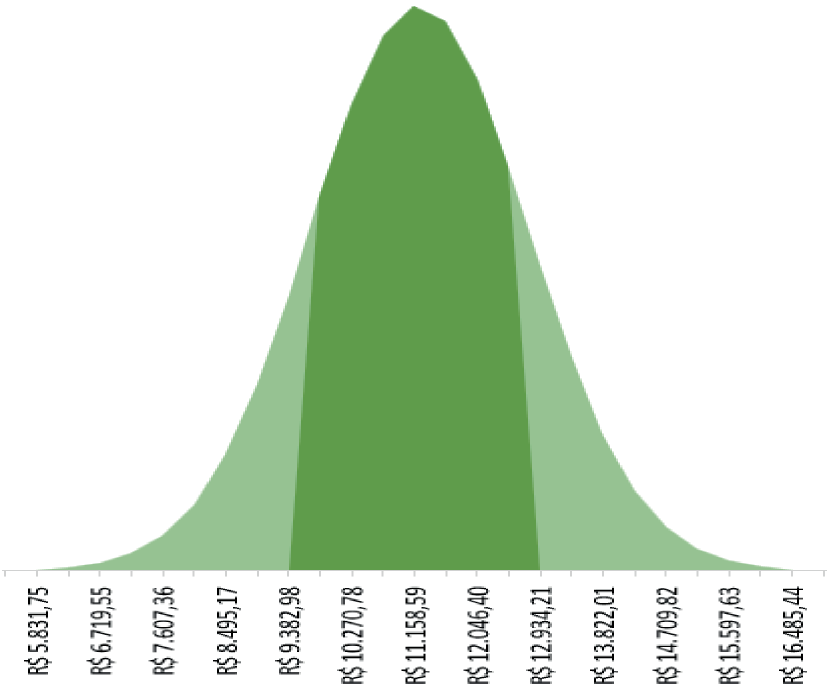

Figure 11: Normal distribution of sample data.

the complete system. As they are complex works, notices and contracts are separated into parts, therefore, a system has several phases and construction stages, each one consisting of specific contracting, generally.

Table 1 presents the data collected throughout the southern region of Brazil and its analysis is presented in Table 2. Table 2 also presents the average values found in the total composition of installation and implementation of the individual system, consisting of septic tank, filter and sinkhole in the same geographic region where the relationship of values was obtained for the absolute separator type collective system. For other collective systems, whether mixed or unitary, no indication was found that these models were being used, therefore values for evaluation were not obtained.

The data contained in Table 1 were processed in a Microsoft Excel spreadsheet. If it was necessary to establish the degree of reliability of the data obtained, for this purpose, the INT.CONFIANCE function was used, which calculates the confidence interval for a population mean, using a normal distribution. To obtain the results, expressed in the main unit of observation, it is necessary to inform the degree of confidence being sought, the standard deviation of the samples obtained and the number of samples. In this case, the degree of reliability is 95%, the number of samples is 56 data points and the standard deviation obtained is R$ 1,538.87. Figure 11 graphically presents the normal distribution of sample data.

Considering data on the implementation of collective collection and treatment systems, especially for the absolute separator system, it was demonstrated that each unit or single-family residence considered, or even each economy, to have a collection system and its treatment installed will cost R$ 11,362.79, on average. It is noteworthy that the degree of confidence in the value found is 95%.

According to data obtained from TABELA SINAPI (02/2023), an installation for collecting and treating sewage through an individual system, considering a residence for up to 5 people with the application of precast concrete parts, in the coverage area in the southern region of Brazil, the average cost varies from R$ 24,008.74 for construction in masonry cast in situ. For the precast system, the values show an extremely significant reduction, reaching almost 1/4 of the cost of the same installation cast on site, with the average value being R$6,197.63.

However, there is a gain in scale when analyzing the different sizes of systems, because while an individual precast concrete treatment system for 5 people costs R$ 6,197.63, for 105 people the average value obtained is of R$ 75,368.37. When transforming the references to *per capita* values, we obtain R$ 1,239.53 per person for the system for 5 people and R$ 717.79 per person for the system for 105 people, thus representing a difference of more than 60% increase in smallest to largest system.

However, for the cast-in-place construction system, the differences are more pronounced, as while the per capita cost for a system for 5 people costs R$4,801.75, for 105 people the average cost is R$1,032.73, that is, the gain in scale in these proportions is more than 3/4 of a reduction in cost with increasing system size.

For collective systems, the scale of implementation is also directly related to the reduction in costs, as costs decrease as size increases.

This way, Figure 12 highlights the scale gain relationship for collective systems. Segmented by system size ranges, this definition is consolidated, that is, as the system increases, there is a decrease in costs related to its implementation.

Graphically, Figure 13 shows the trend

AVERAGE COST PER SAVINGS (R$-US$/Savings)				
COLLECTIVE SYSTEMS			**INDIVIDUAL SYSTEM**	
Absolute Separator	Mixed	Unitary	Molded *in situ*	Pre-molded
R$ 11.362,79	No data	No data	**R$ 24.008,74**	**R$ 6.197,63**
***US$ 2.241,18**	No data	No data	***US$ 4.735,45**	***US$ 1.222,41**

Note: *Average exchange rate for the US dollar in January 2023 (US$1.00/R$5.07).

Table 2: Comparative summary of average installation costs by type of system.

AVERAGE COST INDIVIDUAL SYSTEM - TYPES				
INDIVIDUAL SYSTEM				
	Molded in situ		Pre-molded	
	5 people	**105 people**	**5 people**	**105 people**
Total cost	**R$ 24.008,74**	**R$ 108.436,57**	**R$ 6.197,63**	**R$ 75.368,37**
Cost Per Capita	**R$ 4.801,75**	**R$ 1.032,73**	**R$ 1.239,53**	**R$ 717,79**
Cost per Economy*	**R$ 9.603,50**	**R$ 2.065,46**	**R$ 2.479,05**	**R$ 1.435,59**

Note 1: *Considered 2.5 people per economy.

Note 2: Values based on SINAPI Table 02/2023.

Table 3: Cost comparison between the construction types of individual sewage treatment systems for 5 and 105 people.

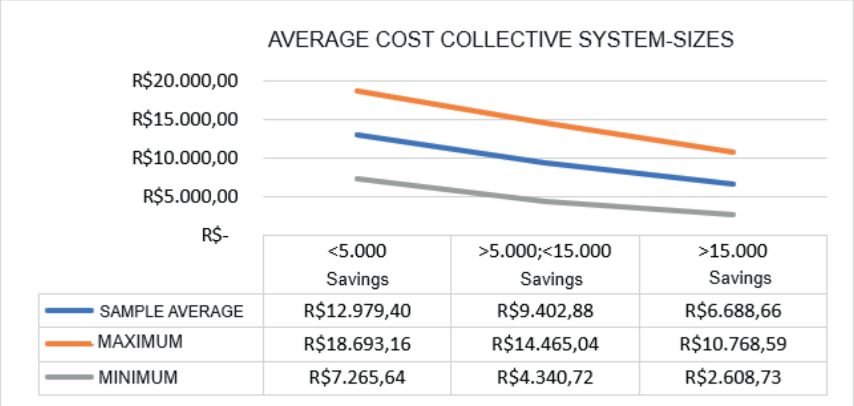

Figure 12: Cost relationship in collective systems by size.

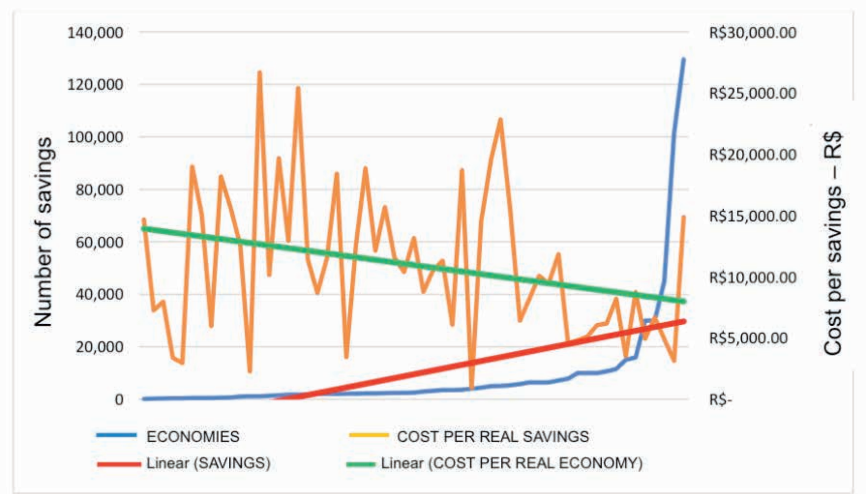

Figure 13: Cost x Size trend curves of systems.

of cost reduction as the size of the systems increases under a global analysis of the samples. It can be seen that in some data there is a very high cost in relatively small systems, however, when analyzing the data set in a systemic way, the tendency to reduce costs with the increase in the number of savings in each system becomes clear. The specific characteristics of each location are factors directly related to cost variation, as it may, for example, have a high implementation cost due to the characteristics of the soil and lithology, as well as its topography.

With regard to the costs of services from the users' point of view, collective systems are based on the water consumption of housing units, that is, a percentage is applied to the measured consumption of treated water, and this percentage has a variation depending on the company providing the services and the respective regulatory standards. Normally this percentage value ranges between 70 and 120% of treated water consumption in Brazil. For individual systems, there is a movement in the State of Rio Grande do Sul to have this service implemented by the company providing SAA and SES, and in this case, a fixed monthly amount is charged and the user has the right to receive an annual collection of sludge from your system.

CONCLUSIONS

Through the propositions of this technical work, the difficulties and challenges of universalizing basic sanitation services and in particular the collection and treatment of sanitary sewage are highlighted. Budget restrictions, combined with high implementation costs, are obstacles to achieving the goals of Plansab and the 2030 Agenda, as well as the updated regulatory framework. In this context, a careful analysis focusing on the rationalization of resources is essential in order to obtain maximum results with the values foreseen for investment.

Given the difficulties in advancing the SES indices, the need for tax relief is assessed with the aim of providing reasonable tariffs to users and ease of cultural attachment to their use, as the counterparts tend to bring benefits in different segments.

It is concluded that there is a gain in scale when observing the variation in the sizes of individual treatment systems, whether in pre-cast construction or cast on site in concrete.

It was evident that collective sewage collection and treatment systems present gains in scale according to their size, reducing installation costs as their number of users increases, in the project. According to the samples used in the analysis, there are quite significant variations between systems of similar size, however, an overall analysis of the samples points to a trend towards decreasing costs as their size increases in relation to the number of users.

There are places with geology or topography that make it impossible to apply one or another type of system, whether the individual system in the case of impermeable or shallow soils, or the difficulties of building networks in rocky soils.

Portions of costs for implementing sanitary sewage systems were found that are not part of the scope of the final composition of the values, such as execution of social technical work projects in the areas covered by expansion and/ or expansion of the systems, topographical surveys, hiring of ETE's automation systems, consultancies, studies of the most diverse natures related to the sewage collection and treatment service, environmental projects, whether for the reconstruction of degraded areas or work to raise awareness among the populations covered, aiming at the use of treatment systems, showing its benefits.

It was not possible to use data from private companies, as they were not available or were not made available.

The implementation of a public maintenance service for the individual system has the characteristic of taking advantage of the infrastructure already installed, a tariff with a fixed value throughout the year and a guarantee of efficiency in terms of treatment.

The implementation of the operation and maintenance of the individual sewage treatment system in a public way avoids the opening of streets, roads and avenues to build the infrastructure necessary for collective systems, as well as the installation of elements or devices for lifting or pumping sewage in lower areas in relation to natural runoff.

The possibility of implementing systems that use installed infrastructure for urban drainage in operation for sewage collection is envisaged, in this case for a mixed system or a unitary system with appropriate routing to an ETE.

In individual sewage treatment systems there is less possibility of environmental damage caused by natural disasters or anthropogenic accidents, as well as greater potential resilient power based on individualized structures.

REFERENCES

Agenda 2030. **Plataforma Agenda 2030.** http://www.agenda2030.org.br/. 2021.

AGERGS - Agência Estadual de Regulação dos Serviços Públicos Delegados do Rio Grande do Sul. **Resolução Normativa N° 50, de 21 de novembro de 2019 Sessão n° 88/2019.** Disciplina a prestação do serviço de limpeza programada de sistemas individuais pela CORSAN.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. **NBR 7229: Projeto, construção e operação de sistemas de tanques sépticos.** Rio de Janeiro, 1992.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. **NBR 9648: Estudo de concepção de sistemas de esgoto sanitário.** Rio de Janeiro, 1986.

BARROS, Rodrigo. Blog Saneamento Básico. **Conheça a história do saneamento básico e tratamento de água e esgoto.** Disponível em

https://www.eosconsultores.com.br/**historia-saneamento-basico-e-tratamento-de-agua-e-esgoto**/. 2019.

BRASIL. Lei n° 14.026, de 15 de julho de 2020. **Novo Marco Legal do Saneamento Básico.** Brasil, 2020. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2019-2022/ 2020 /lei/L14026.htm Acesso em: 01 ago. 2023.

» http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2020/lei/L14026.htm

Brasil (2020). Ministério do Desenvolvimento Regional. **Plano Nacional de Saneamento Básico.** https://www.gov.br/mdr/pt-br/assuntos/saneamento/plansab. Brasília, DF.

Brasil. Sistema Nacional de Informação sobre Saneamento. **Diagnóstico dos serviços de Água e Esgoto - 2021.** Brasília: SNIS, 2023.

BUENO, D. A. C. **Filtros anaeróbios com pós-tratamento em filtros de areia intermitentes: Desempenho em operação crítica.** 2017. 466 f. Dissertação (Mestrado) - Curso de Engenharia Civil, Área de Saneamento e Ambiente, Universidade Estadual de Campinas, Campinas, 2017.

CNI. Confederação Nacional da Indústria. **Comparações Internacionais – Uma agenda de soluções para os desafios do saneamento brasileiro.** Brasília. 2017.

GIKAS, P.; TCHOBANOGLOUS, G. **The role of satellite and decentralized strategies in water resources management.** Journal Of Environmental Management, 2009.

GO Associados. **Ranking do Saneamento Instituto Trata Brasil 2019 (SNIS 2017).** São Paulo. 2019.

GOMES, P. M. e HARADA, A L. **As questões ambientais, técnica e implicação social da locação das unidades operacionais de esgotos.** In: CONGRESSO BRASILEIRO DE ENGENHARIA SANITÁRIA E AMBIENTAL,19., Foz do Iguaçu, PR. 1997. Programa & Resumos. Rio de Janeiro, ABES, Congresso Brasileiro de Engenharia Sanitária e Ambiental,19., 1997.

IBOPE/TRATA BRASIL. http://www.tratabrasil.org.br/datafiles/uploads/estudos/ pesquisa 15/ **Resultados-Pesquisa-Ibope-2012.** pdf.

IDE, C. N. **Qualidade da drenagem pluvial urbana da Bacia dos Açorianos.** Dissertação (Mestrado em Engenharia) – Programa de Pós-Graduação em Recursos Hídricos e Saneamento Ambiental, Instituto de Pesquisas Hidráulicas. UFRGS. Porto Alegre. 1984.

LIBRALATO, G.; GHIRARDINI, A. V.; AVEZZÙ, F. **To centralize or to decentralise: An overview of the most recent trends in wastewater treatment management.** Journal Of Environmental Management, 2012.

METCALF; EDDY. **Wasterwater engineering: treatment and reuse.** 4ª ed. New York: McGraw-Hill, 2003.

NUVOLARI, A. **Esgoto sanitário: coleta, transporte, tratamento e reuso agrícola.** 2a ed. São Paulo: Blücher, 2011.

OMS-Organização Mundial de Saúde in: http://www.direitoshumanos.usp.br/index.php.

TABELA SINAPI. **Sistema Nacional de Pesquisa de Custos e Índices da Construção Civil.** Disponível em https://www.caixa.gov.br/. Acesso em março 2023.

TONETTI, Adriano Luiz. **Tratamento de esgotos domésticos em comunidades isoladas: referencial para a escolha de soluções.** Ana Lucia Brasil, Francisco José Peña y Lillo Madrid, et al. - Campinas, SP. Biblioteca Unicamp, 2018.

TSUTIYA, M. T. BUENO, R. C. R. **Contribuições de águas pluviais em sistemas de esgoto sanitário no Brasil.** Revista Água Latinoamérica. Tucson. Julho/agosto. 2004.

TSUTIYA, M. T.; SOBRINHO, P. A. **Coleta e transporte de esgoto sanitário.** 3a ed. Rio de Janeiro: ABES, 2011.