Sanitation policies and programs in the Metropolis of Rio de Janeiro: an analysis in the perspective of environmental inequalities

Políticas e programas para esgotamento sanitário na metrópole do Rio de Janeiro: um olhar na perspectiva das desigualdades ambientais

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Abstract

Precarious access to sanitation is a major environmental problem in the Rio de Janeiro Metropolitan Region. It negatively affects the population's living conditions and the rivers in this area, being one of the main causes of pollution in the Guanabara Bay. This paper discusses access to sanitation in the region and addresses the historical causes of the deficit and of the environmental inequalities that mark the west side of the Rio de Janeiro Metropolitan Region, focusing on the area known as Baixada Fluminense and on the municipalities located in the Guanabara Bay Watershed. Finally, it seeks to encourage dialogue based on the technical solutions currently presented, especially the treatment given to the theme in the metropolitan plan (PEDUI), approved in 2018.

Keywords: sanitation; public policies; urban planning; Rio de Janeiro Metropolitan Region.

Resumo

A precariedade no acesso ao esgotamento sanitário é um dos maiores problemas ambientais da Região Metropolitana do Rio de Janeiro, afetando negativamente as condições de vida da população e os rios da região, sendo uma das causas principais da poluição da Baía de Guanabara. O presente trabalho discute o acesso ao esgotamento sanitário na região, abordando as causas históricas do déficit e das desigualdades ambientais que marcam o lado oeste da Região Metropolitana do Rio de Janeiro, com foco na Baixada Fluminense e nos municípios situados na Bacia Hidrográfica da Baía de Guanabara. Por fim, busca incentivar o diálogo a partir das soluções técnicas apresentadas atualmente, em especial do tratamento dado ao tema no Plano Estratégico de Desenvolvimento Urbano Integrado da Região Metropolitana do Rio de Janeiro, aprovado em 2018.

Palavras-chave: *esgotamento sanitário; políticas públicas; planejamento urbano; Região Metropolitana do Rio de Janeiro.*

Introduction

Lack of access to sanitation is one of the major environmental issues observed in Brazilian metropolitan areas. It negatively affects the living conditions of the population, which becomes increasingly vulnerable to waterborne diseases associated with individuals' contact with contaminated water and waterbodies in these cities. Several metropolitan rivers have polluted waters, as shown in a study conducted by SOS Mata Atlântica (2019). Costs with depollution are high and require long-term investments; in some cases, high organic matter concentrations, such as the ones seen in the water of Guandu River since the beginning of 2020, hinder water treatment – this river serves more than 9 million people living in Rio de Janeiro City.

The aim of the current study is to address the access to sanitation in this region by taking into consideration its historical causes and the environmental inequalities affecting the Western zone of Rio de Janeiro Metropolitan Region (RMRJ), mainly Baixada Fluminense and districts belonging to Guanabara Bay Watershed (RH5). In addition, the study performed a critical analysis of how this topic is addressed in the Strategic Plan for the Integrated Urban Development of Rio de Janeiro Metropolitan Region (PEDUI – *Plano Estratégico de Desenvolvimento Urbano Integrado da Região Metropolitana do Rio de Janeiro*) approved in 2018.

Based on data recently released by the National Sanitation Information System (SNIS, 2017), districts belonging to RH 5, such as Duque de Caxias, Belford Roxo, Mesquita, Nova Iguaçu[1] and São João de Meriti, present significantly low indicators of sewage collection and treatment. In fact, the main rivers in this region – Sarapuí, Iguaçu and Botas – receive a large amount of untreated sewage that pollute Guanabara Bay when it flows into it. These districts were the target of different programs launched in the mid-1980s, which have failed to assure the access of a significant part of the population to these services.

A vast territory of these districts, except for their downtown areas, does not have access to the sewage collection network. Thus, their residents often discharge sewage into drainage networks or use septic tanks, which are not properly built or maintained. Therefore, inequalities are observed at two different levels: intra-municipal (if one takes into consideration different areas of Baixada Fluminense municipalities) and between these municipalities and Rio de Janeiro City, which presents significantly higher sewage collection rates. Although the treated sewage rate remains low in Rio de Janeiro City, most of its territory is satisfactorily served by a sewage collection network in a separate sewer system, except for some favelas and part of the Western zone of the city.

The precariousness of sewage collection systems available in Baixada Fluminense has raised questions about the adequacy of the model adopted to serve the metropolis throughout history – i.e., the sewage collection in a separate system. The focus of these questions lies on the pollution in Guanabara Bay, whereas the suggested solutions are, above all, based on the need of cleaning up this waterbody.

Based on a wide range of material collected over years of research carried out in the region, the present article is expected

to contribute to the debate about the investigated topic. The study focuses on the historical roots of this issue and associates it with urban growth in the Western zone of RMRJ, which lacks infrastructure for sewage collection and treatment. The first section of the study addresses the environmental inequality observed in the metropolis as theoretical reference to guide the analysis. The second section reconstructs the sewage system implementation process, based on the main projects carried out in Baixada Fluminense, in order to identify the obstacles faced by them. The third section presents the current situation and the way metropolitan planning instruments address this issue, by taking into consideration the recently approved municipal basic sanitation plans and Pedui. Based on the environmental inequality issue, it is possible seeing that, in comparison to the downtown area, a significant part of the Western zone of RMRJ has been historically neglected due to the inefficiency and discontinuity of programs and projects implemented in this region. Most importantly, there is no prospect of serving these areas in the short, or medium, term. The herein presented information was collected from official documents of sanitation programs, from interviews carried out with state government technicians and from secondary sources.

Environmental inequality and investments in sanitation in Rio de Janeiro Metropolitan Region

Since the environmental justice movement emerged in the USA in the 1980s, researchers from different fields have addressed the correlation between housing in risk areas – whether the risk arises from industrial activity, hazardous waste disposal or lack of urban infrastructure – and the socioeconomic features of the population (Bullard, 1994; Acselrad, Mello & Bezerra, 2009; Pulido, 2000) in order to characterize situations involving environmental inequality.

More recently, some researchers have focused on investigating where environmental inequalities come from. Sometimes explanations for this issue were associated with the role played by real estate markets and, sometimes, with the political and decision-making mechanisms linked to the location of unwanted developments and to infrastructure availability.

The literature describes three patterns regarding real estate markets. According to the first pattern, the existence of a polluting venture or activity in a given place would lead to decreased housing values; on the other hand, it would lead higher income families to seek other places of residence and to relegate low environmental quality areas to poor families that have less intra-urban mobility. The second pattern features the construction of affordable housing near environmentally undesirable ventures due to lower land prices. It can also happen in places lacking urban infrastructure, as in the occupation of Baixada Fluminense, which was based on affordable allotments. Finally, the third pattern refers to the implementation of polluting industries, or of other environmentally harmful facilities, in communities formed by minorities due to economic reasons also associated with land pricing (Austin & Achill, 1994 apud Cole & Foster, 2001).

However, these three patterns are not enough to explain different environmental inequality situations. According to Cole & Foster (ibid., p. 61), "free market explanations" try to feature markets as entities external to society rather than as "social institutions shaped by various levels of state and private control". According to them,

> [...] by continuing to describe the forces that underlie racially disparate environmental distributions as "free market" dynamics, the explanation tends to subsume social practices of racial discrimination into rational economic processes and choices. The collapse of social practices of racial discrimination into economic processes subtly expands the domain of "free market" to include, and hence to obscure, racially biased social practices. (Ibid.)

In addition, these explanations are incomplete in the herein investigated case, whose focus lies on inequalities resulting from access to public sewage collection and treatment services. Although the occupation of Baixada Fluminense is linked to lower land pricing resulting from lack of urban infrastructure and from the popular legal and illegalprocess that took place between the 1940s and the 1970s, it is necessary better understanding the reasons why this inequality remains nowadays.

Pulido (2000) advocates that the focus on investigating the implementation of unwanted ventures in the first studies about environmental inequality in the USA made it impossible to have a "more theoretical conception of space" that involves the relationship between places, as well as between places and social processes at different scales. Thus, the aforementioned author advocated for adopting a relational approach, whose emphasis moves from the role played by location and distance to the relationship among different areas in the city (ibid., p. 17).

In fact, the absolute understanding of space based on the theories by Newton and Descartes was widely criticized by Marxist geographers (Harvey, 2006; Corrêa, 2008). According to Harvey (2006), the absolute nature of space, which is the object of standardized measurement, only encompasses one of its dimensions and disregards its relative and relational nature. Space is a relative concept if one takes into consideration that the ways of measuring it depend on observers' reference, whereas its relational nature reveals the inexistence of space in itself, i.e., in separate from the processes defining it.[2] In other words, according to critical geography, space is closely related to social processes; it is, at the same time, the place of, and outcome from, the "reproduction of social relations of production" (Corrêa, 2008, pp. 25-26).

Based on the perspective above, Pulido (2000) and Collins (2009 and 2010) have reinforced the importance of identifying the mechanisms and processes through which elites assure their permanence in the least environmentally impacted areas of the city and/or attract investments to these areas to the detriment of other groups.

Collins (ibid.) has suggested to change the focus from "marginalization" to "facilitation" in order to help better understanding how elites take ownership of scarce financial resources intended for risk remediation through institutionally mediated

processes. According to the aforementioned author, marginalized groups are not the only ones settling in fragile environments; on the contrary, elites often seek such environments in pursuit of environmental amenities (Collins, 2009, p. 591). The difference lies on the fact that elites can make the public power develop risk remediation projects in their housing areas. Indeed, as pointed out by Taylor (2000), economically dominant groups tend to have public policy makers and legislators among their members or in their professional networks, a fact that increases the effectiveness of using lobby as political strategy.

Other studies have similarly highlighted the complexity of spatial, political and social processes leading to environmental inequalities. According to Acselrad (2011), it would be more useful to address environmental vulnerability from a procedural and relational viewpoint in order to set the research focus on political processes whose risk often heads towards the least protected groups.

Vetter, Massena & Rodrigues (1979) have conducted a study focused on articulating land valuation, decision-making processes and lobbying for investments in water and sewage carried out by Cedae in Rio de Janeiro City. They concluded that the center-periphery model played a key role in result interpretation: most of the investments observed throughout the investigated period were allocated to the downtown area, where families with the highest per capita income live in, to the detriment of the periphery, whose residents had lower income. According to the aforementioned authors, investments made in the downtown area were three times higher than investments made in the periphery in the second half of the 1970s, although the population living in the downtown area had better access to sanitation services.

Thus, Vetter, Massena & Rodrigues (ibid., p. 39) have suggested the existence of a "circular causal chain" to explain this investment pattern. Since land value depends on State actions focused on providing infrastructure, and since elites have greater bargaining power, their housing areas proportionally receive more public investments, a fact that makes these areas even more valuable and leads to the expulsion of lower income families. Therefore, there is increased spatial segregation based on income groups and it reinforces the likelihood that these areas, which are now more homogeneously inhabited by elites, will receive even more investments than the housing areas of economically marginalized groups.

Apparently, and according to data presented in other sections of the present article, although the investment pattern has slightly changed since the 1980s (some important projects were developed in Baixada Fluminense), the downtown area of Rio de Janeiro City remains the target of investments, although most of it already has access to universal services.

The next section briefly addresses the urbanization process in Baixada Fuminense and describes the main investments in sanitation, with emphasis on investments in sanitary sewer from the 1980s onwards, in order to start the debate about the persistence of inequalities resulting from an unplanned urbanization process in a context of great social inequality (or from an urbanization process held in a context of "industrialization at low wages", cf. Maricato, 1996).

History of the sanitary sewer system in Baixada Fluminense

The occupation of districts in Baixada Fluminense (BF) started in the 16th century due to sugarcane plantations in large properties. At that time, river transport was the main transportation means to take agricultural products and gold from Minas Gerais to the port in Rio de Janeiro. Thus, prosperous, although small, communities were formed in the river ports of the region (Britto, Quintslr & Pereira, 2019). These communities developed slowly until the 19th century when BF became the outlet route for coffee grown in Paraíba Valley.

Until then, rivers were natural paths that had not been subjected to major interventions, except for routine cleaning procedures to enable navigation. From 1854 onwards, rivers were replaced by railways in transportation processes and most ports were abandoned. The layout of railways led to water damming and the abandonment of river cleaning procedures has worsened the situation. Thus, the second half of the 19th century was marked by relative economic stagnation in the region and by the beginning of its representation as a marshy and unhealthy place, since the meandering rivers and swamps characteristic of the BF territory started to be seen as the focal point of unhealthy conditions (Fadel, 2009).

The Federal Commission for the Sanitation and Clearing of the Rivers Flowing into Guanabara Bay was launched by the Federal government in 1910. Rectification works were carried out in part of Sarapuí River, in addition to the cleaning, clearing and dredging of several rivers. The aim of the canalization and rectification procedures was to make the land attractive to agricultural activity. Oranges from this region were exported to Europe and it enabled the resumption of economic activities in the region. Orange groves covered significant part of the land from 1926 onwards. Baixada Fluminense's sanitation attempts, understood as the elimination of swampy areas, undertaken until the 1930s, allowed the subdivision and occupation of certain areas, albeit in a restricted way – notably the territories referring to the current municipalities of Nilópolis and São João Meriti, in addition to the southern portion of Duque de Caxias (Simões, 2006; Abreu, 1998).

Larger works were carried out by the Commission for the Sanitation of Baixada Fluminense (launched in July 1933) and coordinated by Hildebrando Góes. In 1936, the Commission was transformed into Baixada Fluminense Sanitation Board (DSBF - *Diretoria de Saneamento da Baixada Fluminense*) and subordinated to the Ministry of Traffic and Public Works. The National Department of Sanitation Works (DNOS – *Departamento Nacional de Obras de Saneamento*) was launched in the following year; it had national coverage and DSBF became part of it.[3]

The economic cycle of orange remained active until the 1940s, when exports went into crisis during World War II. The agricultural decline allowed sanitized areas to be gradually incorporated into the urban fabric of Rio de Janeiro City, a fact that enabled its metropolization process (Abreu, 1998).

However, the Sanitation Commission did not foresee the implementation of water supply and sewage networks, since the works

carried out in the region aimed at enabling the agricultural occupation of this space. Despite the lack of infrastructure, the high house pricing in the downtown area of Rio de Janeiro City, as well as the large migratory flow into it, ended up encouraging the allotment of old farms and the sale of lots for residential purposes.

Throughout the 1950s, urban occupation in the region has increased due to the intensification of allotments and to the sale of lots lacking minimum habitability conditions (paving, water, sewage and drainage networks) to low-income workers coming from the capital – these individuals built their own houses. Improvements in the transport system – based on the electrification of railroads and on the establishment of the single railway tariff – have also encouraged the urbanization process in the region (Abreu, 1988). President Dutra highway was launched in 1951 in order to facilitate road transport.

Irregular (developers register the allotment, but they do not carry out the necessary works) and clandestine (without legal registration) allotments resulted from local authorities' permissiveness. However, such permissiveness was functional because, at this time, public financial resources for social housing were very low. Those allotments allowed workers to find housing solutions on their own (Cardoso, Araújo and Coelho, 2007). On the other hand, BF municipalities, which were initially constituted as dormitory-districts for workers from Rio de Janeiro, did not have the resources or the technical-administrative capacity to carry out the necessary works for the implementation of sanitation services. The Charter 1 shows the intensification of allotments in BF since the 1950s.

In the 1980s, the allotment process lost steam due to (1) working class' loss of purchasing power because of inflation and (2) the inhibiting effect of the 1979 federal law, which forced developers to provide infrastructure and reserve areas for the construction of public facilities (ibid.). Thus, a significant portion of lots established in the previous years remained unoccupied.

Charter 1 – Allotments carried out in Baixada Fluminense districts (1949-1980).

Districts	Until 1949	1950-1959	1960-1969	1970-1980	Total in 1980
Duque de Caxias	57.206	85.642	60.038	27.988	230.874
Nova Iguaçu	35.290	244.357	84.982	66.378	431.007
S. João de Meriti	24.811	20.913	3.369	1.244	50.337

Source: Cardoso, Araújo, Coelho (2007, p. 63).

Until 1975, when the former Rio de Janeiro and Guanabara states were merged, basic sanitation services in BF districts were provided by Rio de Janeiro State Sanitation Company (Sanerj – *Companhia de Saneamento do Estado do Rio de Janeiro*). This company provided poor water supply to these districts and sewage networks were virtually nonexistent. According to Brasileiro (1976), there were no sewage systems in the region: domestic sewage in the main centers flew straight to rainwater galleries, whereas other areas often used improvised sanitation tanks and open trenches, which led to severe health damage. Ibam data (referring to the proportion of buildings connected to the network) presented by the aforementioned author highlighted the precarious conditions concerning access to sewage system observed in districts such as Nilópolis (23.7%), Nova Iguaçu (15.1%) and São João de Meriti (44.0%).[4]

It is worth making a quick digression in order to emphasize that Rio de Janeiro City already had the separate sewer system implemented in most of its territory at that time. Although the first contracts signed with Rio de Janeiro City Improvements Company Limited in the second half of the 19th century referred to the "English separate system" – whose network received the sewer itself, as well as the rainwater from internal yards and roofs –, the problems presented by this technology, at the time it was applied in tropical regions, led to the implementation of the separate sewer system in areas depleted since the end of the 19th century. Thus, at the beginning of the 20th century, when the urban reform promoted by Mayor Francisco Pereira Passos increased urban segregation in Rio de Janeiro City, most of downtown areas in the city, in the Southern zone and in the "Great Tijuca" already had a sewer network, as well as some neighborhoods in the Rio de Janeiro suburbs.

The separate system was adopted in Brazil based on projects developed by engineer Saturnino de Brito, mainly on the project designed for Santos City in the early 20th century, which took into consideration the tropical rainfall regime and local topographic conditions. On the one hand, the separate system consisted of a stormwater network and, on the other hand, it encompassed a sewer (or wastewater) network. It was formulated by engineer George Waring for Memphis City (USA) in 1879. He suggested that urban wastewater should be collected and transported in a system separated from the one destined for rainwater collection. The so-called separate sewer system operated at flow rates significantly lower than those of the combined sewer system; thus, it demanded smaller and, consequently, less expensive work (Sobrinho and Tsutiya, 1999, p. 2).

When the merger of the units of the federation into the current state of Rio de Janeiro occurred in 1975, the Rio de Janeiro State Water and Sewage Company (Cedae) was created and became the public company responsible for providing water and sewage services in the new state. Cedae was formed by the merger of the three former sanitation companies in the state, namely: Guanabara State Water and Sewage Company (Cedag – *Companhia Estadual de Águas e Esgotos da Guanabara*), Guanabara Sanitation Company (Esag – *Empresa de Saneamento da Guanabara*) and Sanerj. All three companies had very different features: Cedag had better

economic and financial conditions, as well as well-paid and trained staff; it acted based on conservative technical standards with great political insulation. On the other hand, Sanerj did not have a solid financial situation, it was subjected to significant political interference by the governor's office, which used the operation in hinterland systems as exchange currency in political negotiations with mayors and did not have qualified technical staff. Esag, in its turn, presented intermediate economic and financial conditions, which were similar to those of Cedag. Thus, the merger process was carried out under the strong helm of the most structured company, namely: Cedag (Marques, 1999, p. 53).

Based on Planasa's logic, Cedae has prioritized investments in water supply until the 1980s. The company has also prioritized investiments in water and sanitation in Rio de Janeiro City, were a huge investment was made in the construction of Ipanema under-sea discharge, launched in 1975. Baixada Fluminense sanitation conditions only received effective attention from public authorities from the 1980s onwards.

Global Sanitation Plan for Baixada Fluminense

The first significant sanitary sewage interventions carried out in Baixada Fluminense were organized by Rio de Janeiro State government, under the leadership of Leonel de Moura Brizola, from 1983 to 1986, they were based on the "Global Sanitation Plan for Baixada Fluminense" (PEBs) and aimed at implementing the separate system. PEBs was guided by the following principles: 1) progressivity, intermediate solutions were presented in the first stage, but they should immediately improve population's living conditions; 2) community participation in the selection of alternatives and technical models to be adopted; 3) decentralized solutions through the development of simpler construction systems capable of taking advantage of local conditions at lower operating costs.

The main aim of PEBs was to build 1500 km of sewage collection network in order to benefit approximately 1 million individuals living in Sarapuí Watershed region –120 thousand of them lived in Nilópolis; 290 thousand, in São João de Meriti; 260 thousand, in Nova Iguaçu; and 200 thousand, in Duque de Caxias. The strategy was focused on making decentralized interventions, which characterized different sub-basins as isolated systems. This process enabled avoiding, at least at the first stage, the construction of transport works (large interceptors and outfalls) that together accounted for approximately 60% of the total cost of the project. Thus, projects were implemented by sector, in priority areas (Cedae, 1987).

PEBs also established that studies about different technical solutions for sewage collection systems should be conducted, as well as about the costs and tariffs of these services. The program also included the implementation of micro-drainage systems in the lowest areas – which should protect the implemented sewage collection networks, based on the separate system's logic – and the development of preliminary actions focused on improving local urbanization conditions.

The priority areas for investments were defined based on a study focused on delimiting the most densely occupied areas,

the ones presenting an acceptable system and those often subjected to flood events. Based on this featuring, Cedae has defined Sarapuí Watershed as priority area; it was followed by Pavuna-Meriti and Botas river basins. Local resident associations helped hierarchizing first PEBs stage priorities; this process took place in 1985 and aimed at finding solutions for the main sanitation issues observed in Sarapuí River Basin (Britto, 1998). This articulation was possible due to the close bond between resident associations and government agents, which resulted from agreements set during Brizola's first state administration.

Finally, a pilot experiment was carried out within PEBs' scope in order to implement condominium sewage system in Vilar dos Teles neighborhood, São João de Meriti municipality. Besides sewage, the experiment comprised the implementation of a rainwater drainage system, as well as the paving and afforestation of the main streets. The pilot project was concluded in 1985. Although successful, the implementation of condominium sewage systems has proved to be inadequate, given its low acceptance by residents. Thus, future projects should focus on the implementation of traditional sewage systems – i.e., sewage collection and stormwater networks – to set the separate system.

The crisis in the National Housing Bank (BNH – *Banco Nacional de Habitação*), which was the body financing the project, did not allow the work to be concluded during Brizola's administration; only a small part of what had been planned was completed. The following areas benefited from the project: neighborhoods of the 1st district in Duque de Caxias; the Chatuba neighborhood, which belonged to Nova Iguaçu at that time and that is nowadays part of Mesquita); Jardim Bom Pastor, Jardim Gláucia and Graças neighborhoods, which previously belonged to Nova Iguaçu and currently belong to Belford Roxo); different neighborhoods in São João de Meriti, which was the municipality receiving the largest extent of sewage network.

Although the land division process lost steam in the 1980s and 1990s, BF became denser due to the occupation of the remaining lots and to the construction of several housing units on the same plot of land. At the same time, a social differentiation process has emerged through the consolidation of certain neighborhoods of medium social strata in certain areas. Furlanetto and collaborators have mentioned a "periphery heterogenization" process, mainly in Nova Iguaçu. According to this process, developers invested in the downtown areas of the city equipped with urban infrastructure such as water, electricity, sewage, paving, among others (Furnaletto et al., 1987, apud Lago, 1999, p.15). According to Lago (1999), these developers designed housing for the mid- and high-income population, mainly in the downtown areas of these peripheral municipalities. The service sector was established based on the mid-income classes and new job opportunities emerged in the region; a fact that made Baixada Fluminense districts lose their dormitory-district features.

In addition, it was possible seeing the emergence of favelas, mainly in preserved floodplains (Britto & Cardoso, 2012), due to reduced supply of affordable land in the informal market (Lago, 2007). In other words, changes happened in two different ways, namely: the elitist profile of downtown areas equipped with sewage services and drainage

network; and the expansion of extremely precarious occupations on riverbanks deprived of networks, whose sewage was discharged right into water courses.

Rio Reconstruction Project

A new project focused on the sanitary sewage of Baixada Fluminense – i.e., the Rio Reconstruction Project – was formulated in the late 1980s. It was an emergency project developed in 1988 in response to one of the worst floods that had ever affected the region; it happened in February and March 1988 and left thousands of homeless, and dozens of dead, individuals. The project foresaw interventions in BF and in two other cities affected by summer rains – Rio de Janeiro and Petrópolis. It was funded by the World Bank (Bird), by *Caixa Econômica Federal* (CEF) and by Rio de Janeiro State government. Its main aims lied on infrastructure reconstruction and recovery in the project area damaged by floods, and the implementation of preventive measures of physical and institutional nature in order to reduce the effects of future floods.

The Rio Reconstruction project was elaborated in 1988 and approved in August of that same year; however, it was not actually implemented until July 1990, during Moreira Franco's government, after CEF released US$66.2 million to it, as required by the World Bank. The project incorporated actions focused on implementing sewage systems, as well as macro- and micro-drainage networks – this ordinance remained in force during the subsequent administrations of Leonel Brizola and Marcello Alencar. The construction of the Gramacho System waste stabilization pond in Duque de Caxias was stood out among the planned interventions. Other important interventions made in other districts were reported by Porto (2001, p. 110), as follows: 1) Duque de Caxias – the construction of 60 km of sewage network, 2 lift stations, 1 treatment plant and 4,000 household connections; 2) Belford Roxo – the implementation of 40 km of sewage network, 1 lift station and 1,500 household connections; 3) Nova Iguaçu – the implementation of 30 km of sewage network, 1 lift station and 1,200 household connections; and 4) São João de Meriti – the implementation of 252 km of sewage network, 2 lift stations and 7,500 household connections. The project has benefited approximately 240,000 inhabitants. It is worth emphasizing that Cedae does not often operate by using waste stabilization ponds as an alternative for sewer treatment. The Gramacho sewage treatment plant (STP) stopped operating later on.

According to Duque de Caxias Municipal Basic Sanitation Plan (2017) – (PMSB – *Plano Municipal de Saneamento Básico*), Gramacho STP was designed to serve the sanitary sewer basins of Jardim Gramacho neighborhood and a small part of São Bento neighborhood; it was launched in the early 1990s. STP has faced geotechnical issues since its construction, which is the reason why its deactivation was proposed in the Baixada Fluminense Regional Sanitation Study[5] (*Prefeitura Municipal de Duque de Caxias*, Serpen Coba, 2017, p. 35).

Briefly, sanitation works have only served some BF areas, mainly the downtown areas of the districts; however, the sewage treatment issue was not taken into consideration. All implemented projects have adopted the separate sewer system as technological option.

Baixada Viva Program

A new program involving sanitation works in BF was developed during Marcello Alencar government (1995-1998), the so-called Baixada Viva Program, which was later called Nova Baixada. The program was financed by the Inter-American Development Bank (IDB) and it comprised neighborhood urbanization works to be implemented based on the urban upgrading model. Four pilot neighborhoods were selected at the first stage of the program, namely: Chatuba neighborhood, in Mesquita; Olavo Bilac neighborhood, in Duque de Caxias; Lote XV neighborhood, in Belford Roxo; and Jardim Metrópole neighborhood, in São João de Meriti – approximately 130,778 individuals benefited from it at this stage. The planned interventions included the implementation of water distribution networks and of sewage collection and treatment systems, improvements in the drainage system, urban cleaning and health services, road paving, the implementation of leisure areas and the development of urban projects. Sanitation interventions should be linked to the Guanabara Bay Depollution Program, which will be further addressed.

The basic sanitation works (water, sewage and drainage) aimed at extending the services to all selected neighborhoods. With respect to sanitary sewage, the program foresaw the construction, expansion and recovery of household and intrahousehold networks and connections, as well as the implementation of trunk sewers, lift stations and treatment stations for each neighborhood. Thus, complete systems should be built in the benefited neighborhoods by following the decentralized system construction strategy imposed by IDB. However, the program was developed in parallel to the Guanabara Bay Depollution Program, which designed the sewage systems for BF – these systems were connected to two large STPs, namely: Sarapuí and Pavuna. Thus, based on the perspective that neighborhood sewers would head towards these large STPs, part of Baixada Viva/ Nova Baixada STPs was not built. According to the Regional Basic Sanitation Study, the STPs built within the scope of Baixada Viva Program are no longer in operation (Conen, 2014).

Programs for the depollution of Guanabara Bay: PDBG and PSAM and their impacts on the lives of Baixada Fluminense residents

Guanabara Bay Depollution Program (PDBG – *Programa de Despoluição da Baía de Guanabara*) was launched in 1994; it was funded by IDB and JBIC (Japan Bank for International Cooperation), with counterpart from the state government. The general goals of PDBG were to recover the ecosystems in Guanabara Bay's surrounding areas and to gradually recover the quality of its water, as well as the quality of the water in the rivers flowing into it, by building adequate sanitation systems in its surrounding districts. First, the program foresaw 1,248 kilometers of sewage network and a set of treatment plants. The estimate was that, upon project completion, 239 tons of organic matter would no longer be dumped in Guanabara Bay on a daily basis. However, the discharge of 211 tons of sewage in it would remain unsolved; it should be taken into consideration in a new PDBG stage to be negotiated with financing agents. As widely reported in the academic literature

and in the media, the program's results fell far short of expectations.

The program focused on sanitary sewage, which concentrated most of the investments (51.2%). Actions were planned to create a "sanitary cordon" around Guanabara Bay, based on 1) the construction of five new sewage treatment plants (Sarapuí, Pavuna, Alegria, Paquetá and São Gonçalo); on 2) the renovation and expansion of Penha, Ilha do Governador and Icaraí treatment plants; and on 3) the expansion of the collection network and household connections, mainly in areas of Baixada Fluminense and São Gonçalo districts where sewage systems were virtually non-existent until program implementation.

Two sanitary sewage basins were structured in BF: the Sarapuí basin, where 303 km of sewage collection networks and trunk sewers, 12 discharge lines, 6 lift stations and 1 treatment station at flow capacity of 1m³/s should be built; and Pavuna basin, which did not have organized sanitary sewage system, 403 km of sewage collection networks and trunk sewers, 12 discharge lines, 10 lift stations and 1 treatment station at flow capacity of 1m³/s should be built.

The sanitation component essentially worked with a separate sewer system, based on large STPs that would perform the primary effluent treatment. The PDBG, which was negotiated in 1993 under Brizola's administration, had the peculiarity of crossing different state governments, based on three financing sources. JBIC resources have financed part of the sewage treatment systems (station, interceptors and lift station) in Alegria neighborhood, in Rio de Janeiro City, as well as in Sarapuí and Pavuna, both in Baixada Fluminense. These works were concluded during Garotinho's administration (1999-2002). The construction of collection networks and trunk sewers, which should be based on resources from the state government's counterpart, was implemented with resources mobilized from Fecam; however, work-pace was very slow. A program report published in November 2001 has indicated that only 16% of the planned networks had been installed in Sarapuí System, whereas only 6.8% of them had been installed in Pavuna System (Britto, 2003). The delay in sewage collection network construction persisted under Benedita da Silva and Rosinha Garotinho's administrations.

During Sérgio Cabral's administration in 2008, a new program, the "Sanitation Pact", was formulated. It was an ambitious program that aimed at treating 80% of the state's sewage and at eliminating all dump sites (inadequate waste disposal) within 10 years. In order to do so, resources from the State Environmental Fund (Fecam – *Fundo Estadual de Meio Ambiente*) and from the State Water Resources Fund (Fundrhi – *Fundo Estadual de Recursos Hídricos*) should be mobilized – Fundrhi resources derived from water use fees. The strategy was approved by the River Basin Committees and by the State Council for Water Resources (CERH – *Conselho Estadual de Recursos Hídricos*).[6] The sanitary sewage programs and construction activities were coordinated by Cedae. Rio de Janeiro City application to host the 2016 Olympic Games was presented during this period and, in October 2009, the city was selected to host the event. The Olympic Games' argument was used to resume the Guanabara Bay depollution project, which was even included in the commitments made by the state government. Short- and long-term targets for the recovery

of rivers and streams in Rio de Janeiro City and, mainly, for the recovery of the lagoon system in Barra da Tijuca and Guanabara Bay were defined based on the assumption that this initiative would require expanding the sewage network and building STPs.

Thus, a new program for the sanitation of Guanabara Bay was negotiated with IDB, i.e., the Guanabara Bay Surrounding Districts Sanitation Program (Psam – *Programa de Saneamento dos Municípios do Entorno da Baía de Guanabara*), whose objectives were to reverse the environmental degradation in Guanabara Bay, as well as in Barra da Tijuca and Jacarepaguá Lagoon System, based on the implementation of complementary sanitary sewage systems; to institutionally strengthen the entities involved in the process; and to promote the sustainability of public sanitation policies implemented in the benefited districts. The program made full use of the STPs built by PDBG (Sarapuí and Pavuna), which operated with idle capacity, since the foresaw networks and trunk sewers had not been implemented. The funds derived from IDB, with counterpart from the state government (R$800 million from the IDB and R$330 million from the state government).

Besides Rio de Janeiro City, Duque de Caxias, Belford Roxo, Nova Iguaçu, São João de Meriti and Mesquita were among the benefited municipalities belonging to the metropolitan Western zone. Two trunk sewers should be implemented: 1) the trunk sewer of Pavuna River Basin, which was supposed to collect approximately 1,500 l/s of the sewage coming from Rio de Janeiro, Duque de Caxias and São João de Meriti that, in its turn, should head towards Pavuna STP; 2) the trunk sewer of Sarapuí River Basin, whose final destination was Sarapuí STP – it should collect approximately 1,500 l/s of the sewage deriving from Mesquita, part of São João de Meriti, Belford Roxo and Nilópolis. It is possible seeing that the focus lied on depolluting Guanabara Bay by optimizing the existing infrastructure through the expansion of the sewage volume treated in the STPs. At that time, there was no plan to expand the sewage collection networks in the vast areas deprived of this service, which consequently had not benefited from any program until then. However, works were carried out later on in order to implement a collection network in some Pavuna System areas (Duque de Caxias and São João de Meriti).

Sarapuí and Pavuna STPs were reopened during the second Sérgio Cabral's administration (2011-2014). These systems were ready for secondary treatment at that time; however, in 2014, 20 years after the implementation of the PDBG, the sewage volume treated by these STPs remained below expectations. The Regional Basic Sanitation Study has confirmed this information, which is summarized in the Charter 2.

The aforementioned study has pointed out the low sewage collection rates observed in BF districts located in Guanabara Bay Hydrographic Basin. This outcome has shown that investments that should have been made in the PDBG as counterpart of the state government were much lower than the expected.

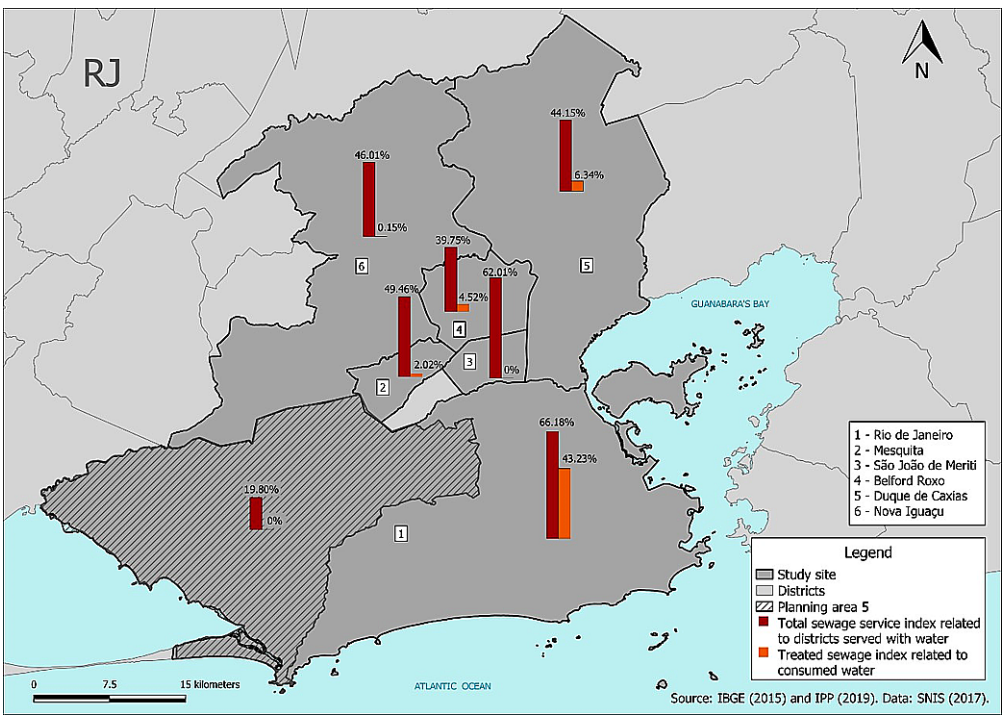
The works foreseen in PSAM for Sarapuí and Pavuna systems had not been put up to bid until the beginning of 2018. Data from Snis (2017) depict the situation in the investigated region.

Chart 2 – Capacity of Sarapuí and Pavuna Treatment Plants and population served by them (2012)

STP System	Nominal (design) flow (L/s)	Current treated flow (L/s)	Current served population 2012	Treatment Level	Served Districts
Pavuna STP	1,500	200	77,000	Secondary	Rio de Janeiro, São João de Meriti, Duque de Caxias
Sarapuí STP	1,500	450	290,000	Secondary	São João de Meriti, Duque de Caxias, Belford Roxo, Mesquita, Nilópolis

Source: Conen (2014).

Figure 1 – Sewage collection and treatment in the study site (2017)



Source: Brasil (2019).

The current scenario

As described in the previous section, a significant part of Baixada Fluminense does not yet have access to sewage services based on the technical model foreseen in projects already carried out – i.e., the separate sewer system. Sewage discharge into the drainage network and septic tanks, or its direct discharge into waterbodies, prevails in most BF districts belonging to Guanabara Bay Hydrographic Region. Such diagnosis is confirmed by municipal sanitation plans developed for districts located in the metropolitan Western zone and by Pedui.

Municipal sanitation plans based on the technical model adopted by Cedae have established proposals (at greater or lesser scale) guided by the absolute separator system. The Regional Basic Sanitation Study (ERSB – *Estudo Regional de Saneamento Básico*) of the metropolitan Western zone was used as basis for the development of these plans. Based on Cedae data, ESRB study has defined the main BF sanitary sewage systems, namely: Pavuna, Sarapuí, Joinville, Orquídea, Botas, Iguaçu and Pilar systems. These systems were established based on two criteria: the sanitary sewage basins and the direct association between a given STP and its operation area – however, Iguaçu, Botas and Pilar systems do not yet have STPs.

The ESRB study has defined the immediate actions to be taken:

> (1) recovering and readjusting the entire sanitation infrastructure to enable equipment modernization and service provision, which, in some cases, means recovering and maintaining the old and depredated structures of the existing systems; (2) elaborating and reviewing basic and executive projects for the whole area of interest in order to eliminate alternative ideas and situations that do not deserve consideration, as well as to find solutions at the best cost-benefit ratio in order to enable and strengthen reliable planning processes. (Conen, 2014, p. 46)

Investments destined to recovery/ implement the sewage collection network and trunk sewers were defined as short-term actions. In addition, it is possible noticing concern with the eventual overlap of investments and projects in the program areas. The same actions should be taken in other areas in the mid-term (10 years).

The municipal sanitation plans developed for the municipalities in question – Belford Roxo, Duque de Caxias, Mesquita, Nova Iguaçu and São João de Meriti – have replicated the proposals of the ESRB study, which comprised the separate sewer system, rehabilitation of out-of-operation STPs and construction of new STPs, whenever necessary.

Briefly, the existing municipal planning instruments foresee the installation of a separate sewer system. Cedae has been operating based on this technological paradigm since it was launched. The first (and only) Master Plan for Sanitary Sewage in Rio de Janeiro Metropolitan Region, formulated in 1994, addresses this idea. According to Ferreira (2013), the implementation of separate systems is traditionally adopted in Brazil, since it is the most efficient system working under Brazilian climate conditions, it was ratified by ABNT through NBR regulation n. 9648 from 1986, which provided for the

conditions required in studies about the design of sanitary separate sewer systems (ibid., p. 9). Volschan et al. (2009) have published an essay in DAE journal, according to which the comparison between combined systems and separate systems shows the technical, economic and environmental advantages of the separate sewer system in force in Brazil, mainly if one takes into consideration rainfall rates in tropical climates.

However, RMRJ experiences the same situation often found in other Brazilian cities, as pointed out by Fadel and Dornelles (2015): adaptations in the rainwater system so it behaves as a unit that also collects sewage (or a combined sewers system). According to the aforementioned authors, the so-called "combined systems" are found in many districts, not due to infrastructure planning, but due to lack of sanitary sewage network or to irregular untreated sewage connections in the drainage network.

The Strategic Plan for the Integrated Urban Development of Rio de Janeiro Metropolitan Region (Pedui – *Plano Estratégico de Desenvolvimento Urbano Integrado da Região Metropolitana do Rio de Janeiro*) was elaborated in 2018. According to the analysis of the sanitary sewage system in the metropolis, Pedui has indicated that the service coverage remains flawed. In addition, sewage treatment is even more incipient, which indicates the existence of unplanned interconnections between sewage and drainage systems, a fact that leads to urban degradation and to low environmental quality. The document has also indicated that the use of combined networks, which share sewage and rainwater, requires a specific project that does not simply refer to sewage discharge into rainwater networks. However, there is no project focused on building a combined network suitable for this use in the metropolitan territory. Pedui has pointed out that the simple connection of domestic sewage to drainage networks means that untreated effluents are directly discharged into the receiving body. According to the separate system adopted by Cedae over the years, the drainage networks implemented by local governments were designed to exclusively receive rainwater; therefore, they do not encompass any treatment process.

Pedui takes into consideration the difficulty of installing networks and trunk sewers in Baixada Fluminense in the short term. It suggests implementing sanitary cordons along the main rivers of Baixada Fluminense, with dry weather treatment, in order to improve the quality of the water in Guanabara Bay. The application of this technology means that these cordons will collect the effluents from the drainage and sewage networks reaching the rivers and send them to be treated in Sarapuí and Pavuna STPs during low rainfall periods ("dry weather"). Sewage and rainwater will be directly released into the rivers during intense rainfall periods in order to avoid exceeding the capacity of STPs.

According to Ferreira (2013), there is a recent movement in Brazil that advocates for the implementation of the separate sewer system in gradual stages. Thus, places already equipped with drainage systems receive investments for STPs; connections or derivations are implemented to enable controlling sewage discharge into waterbodies during the dry season (or in "dry weather"). Subsequently, sewage collection networks are installed. The system requires qualified management to control the overflow of

surplus (project) flows, i.e., to control what will be released in the rivers during the rainy season. This control is determined by law in countries that adopt this solution. According to the aforementioned author, the rules of the Environmental Protection Agency (EPA) in the USA determine that a Plan to Control the discharge of water deriving from combined systems should be implemented; they also define the maximum limit of four annual combined sewage release events, i.e., four overflows. The implementation of this intermediate solution must be extremely careful in areas subjected to high rainfall and flood peaks, such as Baixada Fluminense, whose drainage systems lack adequate planning and management by local governments.

The main objective of this solution adopted in Pedui is to act on the compromised quality of the water in waterbodies that flow into Guanabara Bay. The herein problematized matter lies on whether, by adopting this model, the metropolitan plan and policy would not be giving up on effectively addressing the sewage infrastructure necessary to serve all basins contributing to Guanabara Bay, mainly the ones located in Baixada Fluminense, which nowadays lack collection networks and adequate drainage network, a fact that reinforces social exclusion. Accordingly, it is essential highlighting the environmental inequality between peripheral districts in Rio de Janeiro State and Rio de Janeiro City, where the option made for the separate sewer system was used as basis to structure the systems, which were progressively implemented and currently serve the largest part of the local territory.

Thus, if one takes into consideration the benefits to the population, it is possible questioning whether the priority adopted by Pedui, as pointed out by the PMSB of Duque de Caxias, refers to the conventional sewage infrastructure necessary for Rio de Janeiro Metropolitan Region. This questioning is necessary, mainly if one takes into consideration the history of the herein presented programs and the already mobilized volume of resources. There is a clear inefficiency issue in the planning and management of systems that were not mentioned in Pedui's diagnosis. This inefficiency mainly affects the most deprived areas of the metropolis, such as Baixada Fluminense districts. Once Pedui solution is adopted, investments in these areas tend to be postponed again.

Final considerations

The analysis applied to the history of programs and projects focused on implementing sewage collection and treatment services in districts located in Guanabara Bay Hydrographic Region in the metropolitan Western zone has shown that, although these services are strategic to help improving the living conditions of the population and the quality of the water in Guanabara Bay, results fell far short of expectations. Nowadays, a large number of individuals living in Baixada Fluminense do not have access to sanitary services and Guanabara Bay remains polluted. Although investments from the state government were announced as priority, they were successively postponed, both when there was great

resource availability and in the recent financial crisis faced by Rio de Janeiro State.

In addition, municipalities' participation in programs demanding their effective implementation was non-existent. The hegemony of the state government in the definition of policies and benefited areas, as well as municipalities' delegation of sewage management to Cedae, in association with the fact that the systems are integrated and exceed the local limits, contribute to local governements' "unaccountability".

The analysis of the programs has also shown waste of public resources; areas that were the object of investments in the 1980s started receiving resources again 20 years later, since the incomplete systems (networks and STPs) have favored the degradation of the implemented infrastructure.

At the same time, some areas that were never contemplated by the herein presented projects remain without investments; thus, this investment pattern reinforces the environmental inequalities marking the metropolitan territory. Symptomatically, noble areas in Rio de Janeiro City, mainly Recreio dos Bandeirantes and Barra da Tijuca, which present better sanitation indicators, have also received major investments in recent years. Cedae has been carrying out works in these areas based on the sanitation project developed for Barra da Tijuca, Recreio dos Bandeirantes and Jacarepaguá; this project foresaw the implementation of a separate sewer network, STPs, lift stations and a submarine outfall that started operating in 2006 (Cedae, s/d).

The restricted description of programs developed for the metropolitan periphery is one of the limitations of the current study, since it limits the understanding about inequalities in access to sanitation between Rio de Janeiro City and Baixada Fluminense. Future studies should address investments made in downtown areas that are already equipped with sanitation services, although they keep on receiving financial resources in a pattern that may resemble the circular causal chain suggested by Vetter, Massena and Rodrigues (1979).

Finally, it is important emphasizing that nowadays, after Psam suspension, there is no program aimed at providing sewage collection services to Baixada Fluminense. There is only one proposition (detailed in Pedui) focused on increasing the volume of treated sewage through the installation of sanitary cordons along the rivers in order to collect sewage during the dry season and take it to Sarapuí and Pavuna STPs, in addition to the current proposition to enable the expansion of sewage collection systems by granting the sewage services provision to the private sector. Thus, lack of projects aimed at providing sanitary sewage to underserved areas in Baixada Fluminense ultimately reinforces the existing inequalities.

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Notes

(1) Nova Iguaçu covers 54% (517.8 km2) of the local territory in Guanabara Bay Watershed Region.

(2) For an in-depth debate about the natures of space, see Harvey (2006).

(3) It is essential emphasizing that, until then, the name BF was used to refer to all coastal plains located between the coast and Serra do Mar in Rio de Janeiro State.

(4) Data about Duque de Caxias district are not shown.

(5) Baixada Fluminense Regional Sanitation Study (ERSB – *Estudo Regional de Saneamento da Baixada Fluminense*) was requested by the State Secretariat for the Environment (SEA-RJ) within the scope of the Sanitation Program for Guanabara Bay Surrounding Districts (PSAM – *Programa de Saneamento dos Municípios do Entorno da Baía de Guanabara*), and it was concluded in 2014.

(6) The Water Use Charge Law in Rio de Janeiro State (law n. 4247 from 12/16/2003) was changed by state law n. 5234/2008, which authorized rebalancing the water use charge by the sanitation sector. The new law has also established that, at least 70% of the funds collected through this charge should be applied to sewage collection and treatment processes until 80% of sewage collection and treatment in the respective hydrographic region was reached.

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