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Expansion analysis of urban microdrainage in Sergipe cities

Análisis de la expansión del microdrenaje urbano en las ciudades de Sergipe

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Abstract: We aim to explore the criteria surrounding urban microdrainage, as well as analyze its expansion in the state of Sergipe. The investigation was carried out based on data made available by the National Sanitation Information System (SINIS), using the years 2017 to 2021 as a reference. The growth in the number of public roads and data on variations in the number of gutter inlets will be analyzed in each of the 75 municipalities in Sergipe. To survey and analyze the development in each municipality of Sergipe, EXCEL was used to organize the data and create graphs for analysis.
Keywords: *Gutter inlets; Drainage; Public roads.*

Resumen: Se pretende explorar los criterios sobre microdrenaje urbano, donde el objetivo principal es analizar la expansión del microdrenaje en el estado de Sergipe. La investigación se llevó a cabo con base en los datos proporcionados por el Sistema Nacional de Información de Saneamiento (SINIS), utilizando los años de referencia 2017 y 2021. Donde el crecimiento en el número de vías públicas y los datos de las variaciones en el número de bocas de lobo que cada uno de los 75 municipios de Sergipe se analizarán tienen. Para levantar y analizar el desarrollo en cada municipio de Sergipe, se utilizó EXCEL para organizar los datos y crear gráficos para el análisis.
Palabras clave: *Bocas de lobo; Drenaje; Vías públicas.*

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INTRODUCTION

Drainage plays an important role for people living in urban areas, as it is the main means of draining rainwater. The design of the drainage system must be incorporated into urban planning, as its absence or inadequate functioning leads to various problems, with significant social impacts. Among these problems are floods, flash floods, worsening of the spread of disease, material damage, and loss of human life (Falcão, 2021).

With population growth and technological advances, there has been an increase in the use and occupation of territories. These uses lead to changes in the soil, watercourses, forests, or woodlands, and have numerous negative consequences. As the population grows, urbanization increases, also due to migration from rural areas to urban centers in search of a better life. This process has intensified over the years in the face of technological advances, affecting everything from small towns to large global metropolises (Nascimento, 2021).

According to Höltz (2011), with the waterproofing of the soil, caused by urban growth, some of the problems caused by this expansion arise, such as flooding, which is generated by the precarious management of rainwater on public roads. According to the same author, to try to solve the problem, the public power, in many places, has adopted the strategy of expanding the drainage network. It happens because, based on a well-dimensioned drainage network, under regulatory standards, flooding caused by rain due to the low permeability of urban soils would be greatly reduced.

According to Lima and Filgueira (2018), Brazil's urbanization process was characterized by its speed and intensity, but this process was not accompanied by the necessary infrastructure. It means that much of this occupation process has been disastrous, resulting in environmental degradation. Given the above, this study aims to evaluate the expansion of urban microdrainage in cities in the state of Sergipe between 2017 and 2021, using data from the National Sanitation Information System (SNIS, 2022).

THEORETICAL BACKGROUND

Urban microdrainage

According to Matos (2021), urban microdrainage can be defined as a set of techniques that aim to manage rainwater in urban areas, preventing flooding in small areas such as: urban streets, avenues, squares, parks, and residential and commercial areas. Its components are gutters, rainwater galleries, gutter inlets, retention boxes, permeable paving, and rainwater storage and infiltration systems.

The Ministry of Integration and Regional Development (2022) reports that:

> "Because of the alterations to natural systems resulting from urban occupation and soil sealing, it is necessary to introduce artificial structures - engineering works - to control the spontaneous flow of rainwater. This is done to avoid impacts on the population living in cities."

The principle of urban microdrainage is to capture the water that drains onto public roads because of rainfall on urban perimeters. According to the National Water and Basic Sanitation Agency (ANA), through SINIS (2018), the survey found that of the 3,603 Brazilian municipalities that provided data for the survey, only 54.8% have microdrainage systems and 24.6% have only a single rainwater system that is not exclusive to drainage. Brazil currently has 5,570 municipalities according to the Brazilian Institute of Geography and Statistics (IBGE 2016). Of this number, only 719 Brazilian municipalities have a drainage master plan.

For the best application of microdrainage in the municipality, some of them have an urban drainage master plan, which presents methods for the administration of urban infrastructure, whose focus is on the drainage of rainwater from rivers and streams in urban areas (Prefeitura Municipal de Porto Alegre 2005). The creation of a drainage master plan for a municipality has the purpose of ensuring the good performance and development of the drainage system, while also aiming for environmental control to mitigate impacts on the environment. With the urban drainage master plan, it is also possible to control and organize the urban growth of cities.

In Brazil, there are currently around 60 infra-national agencies whose goal is to oversee the provision of basic sanitation services, which includes water supply, sewage collection and treatment, waste collection and disposal, as well as rainwater collection and management, according to ANA(2022). The reports presented by ANA(2022) shows that in Brazil, only approximately 65% of the municipalities are linked to and supervised by the infra-national agencies, which represent around 3,620 Brazilian municipalities, while the remaining 1,950 municipalities are not linked to sanitation supervision agencies.

METHODOLOGY

Study area

The state of Sergipe is located in the northeast of Brazil. It is the smallest state in terms of land area in the country, and it borders Bahia, to the west, and Alagoas, to the south. Its capital is Aracaju, which is also the smallest state capital in Brazil.

FIGURE 01: Map of the Northeast Region of Brazil.

SOURCE: Geography Blog (2010).

According to the latest IBGE demographic census (Brazilian Institute of Statistics and Geography, 2022), the state of Sergipe has approximately 2,209,558 inhabitants. Furthermore, the state is made up of 75 municipalities and has a territorial area of 21,938.188 km².

According to Bechara (2009), research techniques are the set of methods used to carry out scientific research or investigation. Initially, secondary data was collected from the National Basic Sanitation System (SNIS, 2022), which deals with the annual diagnosis of drainage and management of urban rainwater in the period from 2017 to 2021. To this end, three indicators were analyzed, and then Excel was used to process the data and draw up the graphs.

Once the graphs had been created, the analysis was carried out and the discussions presented. The indicators used in this work are described below, according to SNIS (2022):

a) IE019 - Total extension of urban public roads with pavement and curbs (or similar);

b) IE021 - Number of gutter inlets in the municipality; and

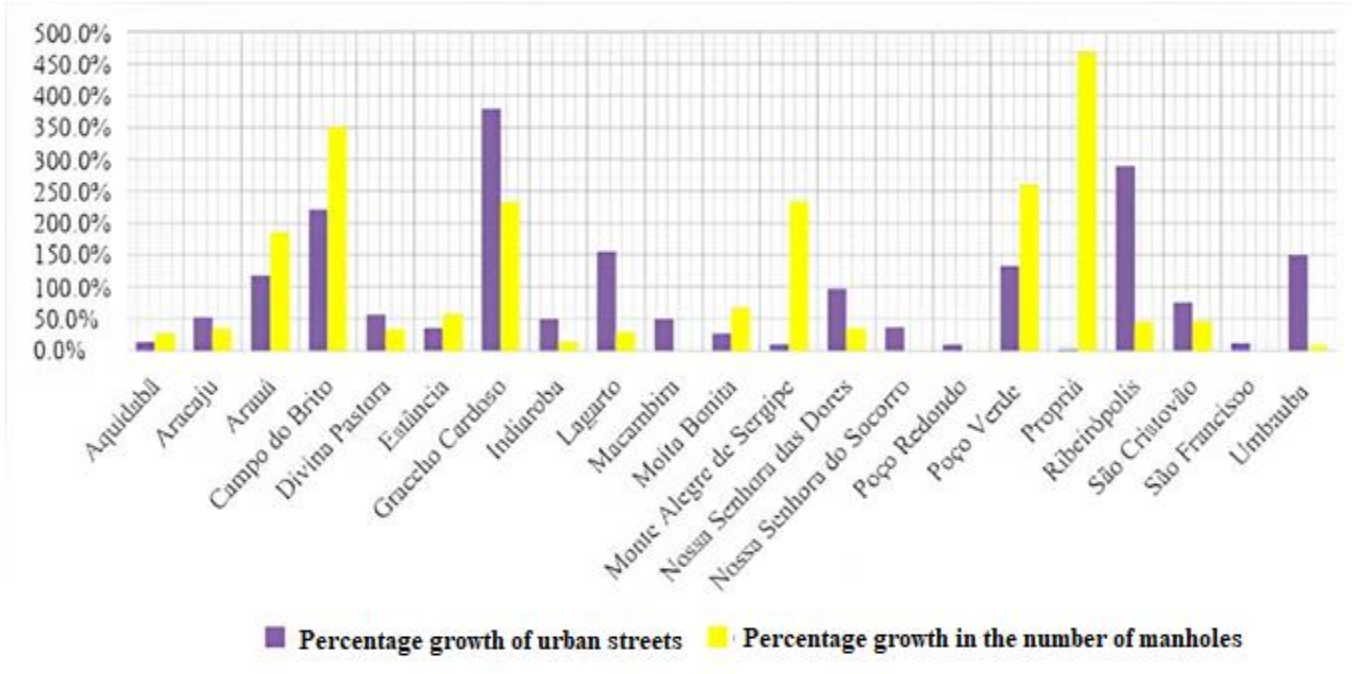
c) IE022 - Number of gutter inlets or multiple (two or more gutter inlets combined) in the municipality.

To evaluate the expansion of the microdrainage, the number of gutter inlets (simple and multiple) was considered; and its percentage growth in the period, to then be compared with the percentage growth, in the same period, of the length of urban roads with pavement and curbs.

RESULTS AND DISCUSSION

After collecting the data, a graph was created showing the percentage growth of urban roads with pavement and curbs, comparing this information with the percentage growth in the number of gutter inlets. The results are shown in Graph 01.

GRAPH 01: Growth in paved urban roads versus the number of gutter inlets in cities in Sergipe between 2017 to 2021.



SOURCE: The authors (2023).

After collecting and analyzing the data, it was possible to use information from only 21 (twenty-one) municipalities in Sergipe according to the availability of SNIS for the years 2017 to 2021. Although the state of Sergipe has 75 (seventy-five) municipalities in its division, only 28% presented complete data in the SNIS database. The remaining 54 (fifty-four) municipalities did not submit sufficient data, 30.67% of the municipalities submitted inconsistent data, 6.67% kept the data unchanged over time and 34.67% of the municipalities did not have the data chosen for the research. Of the 21 municipalities analyzed,

38.1% (8 municipalities) showed a higher percentage growth in gutter inlets in relation to the number of public roads, with Propriá standing out as having a 463.7% increase in the number of gutter inlets.

The other 13 municipalities (61.9%) saw a greater increase in public roads than in gutter inlets. Ribeirópolis stands out, with a 245.2% increase in urban roads compared to gutter inlets. It is worth highlighting the cities of Muribeca, Nossa Senhora do Socorro, Poço Redondo, and São Francisco, which registered an increase in gutter inlets in the period analyzed. The city of São Francisco is also noteworthy for the fact that, according to SNIS, it has only one manhole in its entire 09 km of public roads.

In this way, we notice that despite the growing number of public roads in Sergipe's cities, the number of drainage means such as gutter inlets, for the most part, does not follow the same pace of evolution and development. Despite the existence of standards for the application and handling of the drainage system in more than 50% of cities, it is not widespread.

It's worth noting that some of the high percentage figures refer to growth that isn't as significant as it seems since cities like Arauá, Gracho Cardoso, and Poço Verde saw an increase of 13 units of gutter inlets in the period surveyed, but the percentage growth in these cities is 185.7%, 233.3% and 260% respectively.

CONCLUSIONS

According to the data obtained, we can conclude that:

- Although the state of Sergipe has 75 municipalities in its division, only a subset of 21 municipalities provided sufficient data for this analysis. This shows the need for further expansion of data collection and continuous monitoring, to make the process of evaluation and decision-making regarding the urban drainage network more effective;
- In only 38.1% of the cities analyzed, did the percentage growth in gutter inlets keep pace with and/or exceed the growth in waterproofed areas, which leads to the conclusion that a more critical look at urban planning and urban drainage management is needed;
- The growth of micro-drainage devices (gutter inlets) is not keeping pace with the growth of the waterproofed area, represented here by paved urban roads, which requires the public bodies responsible for managing these systems to take a closer look and be concerned about the future consequences, as well as maintaining the *status quo*;
- It is important to emphasize that municipalities must have an urban drainage master plan and be supervised by infra-national agencies that provide a regulated, orderly and quality service to the municipal population.

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