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Urban Disposal from Civil Construction and its Relation With Public Health

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ABSTRACT
This study explores the link between the management of construction waste and the incidence of dengue in Campinas, highlighting the importance of sustainable practices and the role of public authorities. Between 2018 and 2021, the exemption from the onerous grant of the right to build indicated a possible increase in construction activity, coinciding with the growth of dengue cases, exacerbated by atypical climatic events and floods that created areas conducive to the proliferation of the Aedes aegypti mosquito. By analyzing data on issued permits, dengue case records, and rainfall, the study seeks to understand how urban and environmental dynamics affect public health. It emphasizes the need for an integrated approach that involves public policies, solid waste management techniques, and community awareness to discuss the risks of dengue proliferation in urban areas.

KEYWORDS: Solid Waste. Water in the Urban Environment. Aedes aegypti.

INTRODUCTION

The issue concerning solid waste generated in urban spaces, beyond the environmental theme, also relates to public health, which in turn is linked to the city, housing, and urban dynamics. Considering the rapid growth of constructions in cities, interventions are carried out to meet the population's needs, including housing. The update of services and the adjustment of standards promote renovations and demolitions, generating Construction and Demolition Waste (CDW). The raw material for these products is largely generated by mining activities and with high energy consumption, including from non-renewable sources (Silva Neto; Silvestre, 2013). Thus, measures are necessary to make the city's dynamics viable, minimize conflicts, and reduce impacts, gathered, for example, in municipal master plans.

The construction industry is significantly present in cities, accompanying or driving growth in a cyclical way, where the increase in population enables new constructions, while the development of civil activity encourages public interest in experiencing it. Therefore, the various specificities of civil construction, such as demolition, expansion, requalification, restoration, and construction itself, are attributions of the transformation of the city, shaped according to local characteristics of spatialization, demographic profile, socio-environmental factors, among others (Acselrad *et al.*, 2008).

The abandonment of CDW and other waste in inappropriate locations, outside the routine of public collection, can lead to an increase in the shelter of disease vectors, among them the Aedes Aegypti mosquito, which transmits diseases such as dengue, chikungunya, and Zika. This article addresses the study of dengue, a disease considered neglected by the WHO (2022), a multi-causal illness, and its possible relationship with the dynamics of space production through demolitions and new constructions, waste generation, and public cleaning, understanding this problematic and neglected scenario in the urban reality.

OBJECTIVES

The main objective of this article is to analyze the possible relationship between the waste generated by civil construction and the incidence of dengue in the municipality of Campinas, considering aspects such as the interaction between public policies and sustainable practices in the urban context. Specifically, this study focuses on the period between 2017 and

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2022, particularly examining the period when the exemption from the onerous grant of building rights was implemented in Campinas between 2018 and 2021, seeking to verify whether the changes significantly influenced the local environmental sustainability and public health.

This analysis will be based on cross-referencing data from the mapping of construction and demolition permit emissions with dengue incidences, aiming to establish the relationship between urban environmental management and the occurrence of diseases. Thus, the article not only contributes to academic literature but also offers the analysis of practical aspects for the discussion of more integrated and effective public policies.

AREA OF STUDY

The municipality of Campinas, located in the central-eastern part of the interior of the State of São Paulo, Brazil, is the focus of this study. Campinas is approximately 96 km northwest of the state capital, São Paulo, occupying an area of about 795 km² with a population of 1,139,047 inhabitants (IBGE[1], 2022).

The RMC (Metropolitan Region of Campinas), the second largest in the State of São Paulo, covers approximately 3,791.79 km² and has an estimated population of 3,306,358 inhabitants (IBGE, 2022). The region periodically faces water challenges, competing for natural resources with the Cantareira System, resulting in water scarcity and difficulties in expanding the water supply and sewage network over the past 50 years. The RMC is part of the Capivari, Piracicaba, and Jundiaí river basins, predominantly using surface water for supply, industrial, and agricultural use. Despite occupying less than 0.18% of the country's area, the RMC concentrates[2] 2.7% of the national population and generates about 5% of the GDP.

Currently, Campinas is an economic center comparable to various state capitals, with a population dynamic interconnected by five major highways and the Magalhães Teixeira ring road, consolidating its prominent position in the Metropolitan Region of Campinas (RMC). According to the Municipal Integrated Solid Waste Management Plan, the city's large territorial area, high population number, and diverse social profiles result in intense construction activity to meet urban demands, which consequently leads to significant solid waste generation in the built environment (Campinas, 2021).

Between 2007 and 2015, the municipality of Campinas faced three major historical dengue epidemics during the analyzed period, responsible for more than 123,000 notifications of autochthonous cases of this infectious disease. Research conducted in the municipality showed that part of the difficulty in controlling dengue is due to the large proportion of closed houses and refusals, making inspection and vector control difficult. Additionally, it was observed that the groups most affected by the disease are also those characterized by worse socioeconomic indicators (Johansen, 2018). The municipal territory is organized in different ways, one of the most used being the subdivision by areas covered by Health Centers, which was chosen to analyze the relationship between the incidence of dengue and construction and

[1] Brazilian Institute of Geography and Statistics.

[2] Recent IBGE (2023) data shows that urban communities in Brazilian metropolitan regions face significant challenges in infrastructure and public service access.

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demolition activities, using the local bivariate Moran index to identify significant spatial clusters and their implications for public health and urban sustainability.

METHODOLOGY

DATA

Permits for the construction of vertical and horizontal multifamily residences, as well as mixed-use buildings (residential and commercial), and partial and total demolitions were selected. Kernel density mapping, which calculates densities based on the execution permit points, creating a 'density spot,' was also used. The mapping of execution permits issued in the city of Campinas was gathered for three distinct periods: the year 2017, one year before the exemption of the onerous grant of the right to build; the exemption period, between 2018 and 2021; and the year following the exemption, 2022.

The high rainfall indices of the city, with rains equal to or greater than 50.0 mm, were also recorded.

Table 1 – Recorded data of rains above 50.0 mm in Campinas from 2017 to 2023

Rainfall and Temperature Data in Campinas from 2017 to 2023		
Date	**Temperature**	**Rainfall**
01-17-2017	20,2°C	52,0 mm
01-22-2017	21,0°C	57,0 mm
01-13-2020	24,1°C	87,0 mm
10-08-2023	22,4°C	52,0 mm
10-09-2023	21,3°C	57,0 mm

Source: National Institute of Meteorology (INMET)

We collected dengue data from 2017 to 2022, separated by the coverage areas of the Health Centers, using epidemiological bulletins from the Health Department and the Department of Sanitary Surveillance, which provide detailed information on cases reported weekly and their geographic distribution. We organized this data according to the coverage areas of the Health Centers, cross-referencing it with complementary data for validation, and ensured temporal accuracy by collecting data before, during, and after the exemption of the onerous grant of the right to build. This allowed us to observe temporal and geographic variations in dengue incidence and its correlation with construction and demolition activities in the city.

SPATIAL ANALYSIS

For the development of spatial analysis, readings of the dispersion of permits across the territory were made using Kernel density. We then applied the local bivariate Moran index to conduct the spatial analysis. This index helps identify significant clusters of dengue incidence in relation to construction and demolition activities. We applied the method considering dengue cases as the dependent variable and the number of executed permits as the independent

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variable to visualize the relationship between both in this study, allowing for a detailed analysis of the dynamics between urban development and public health (Waller; Gotway, 2004).

PROCEDURES

The methodological procedures followed these steps:

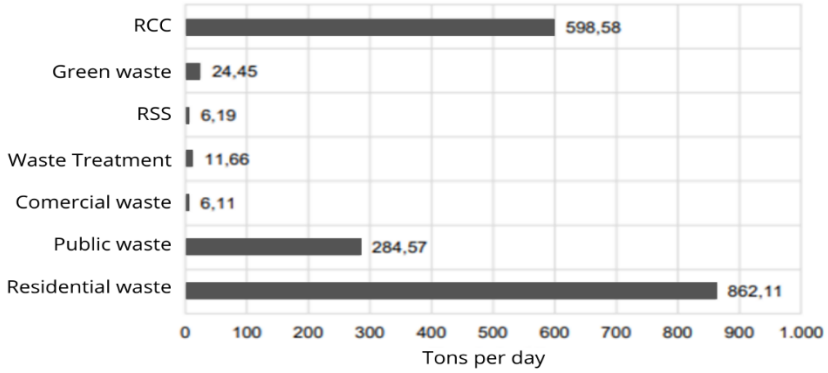
- **Data Collection**: We gathered execution permits and dengue data from the specified periods. We also collected highlighted rainfall and temperature data.
- **Data Organization**: We organized the data into tables and maps, separating them by the coverage areas of the Health Centers and analysis periods.
- **Density Mapping**: We used kernel density mapping to visualize the densities of execution permits.
- **Cluster Analysis**: We applied the local bivariate Moran index to identify significant clusters.
- **Results Interpretation**: We analyzed the identified clusters to understand the relationships between waste management, dengue incidence, and construction and demolition activities.

RESULTS

CDW in Campinas

In Campinas, the municipal sanitation plan addresses the situation of waste generated in the year 2020 (Figure 1), highlighting one of the highest indices: Construction and Demolition Waste (CDW).

Figure 1 – Quantity and Typology of Solid Waste Generated in the Municipality of Campinas (2020)



Source: Department of Urban Cleaning, 2023 (DLU).

Construction and Demolition Waste (CDW) consists of materials originating from constructions, renovations, repairs, and demolitions of works (IBGE, 2010) of any size, which must be properly segregated and disposed of (Conama, 2002).

A significant portion of CDW can be reused or recycled as part of the raw material for new constructions (Serinolli, 2021). However, this often does not happen, and in municipalities, a large part of the volume of this waste is not recycled. In Campinas, between December 2022

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and May 2023, only 9% to 22% of the material received was recycled, which did not reach the total average of the waste generated, according to the relationship of execution permits for the works (Figure 2) issued during this period, and the daily quantity of waste generated (Figure 1).

Figure 2 – Record of the Issuance of Execution Permits in Campinas by Month

Source: Campinas, 2024.

Table 2 – Quantity of Construction and Demolition Waste Destined to the Material Recycling Plant

Quantitative from Material Recycling Plant (URM)						
Month	Dec/22	Jan/23	Feb/23	Mar/23	Apr/23	May/23
CDW (m^3)	22.341	22.782	20.607	31.288	24.867	25.916
% Recycled	9%	6%	10%	20%	27%	22%

*** CDW– Construction and Demolition Waste**

Source: Departament of Urban Cleaning, 2023 (DLU)

Generators of Construction and Demolition Waste (CDW) have two suitable disposal alternatives in Campinas: ecopoints or hiring companies for dumpster rental and CDW transportation.

Ecopoints are locations where residual materials of different classifications can be voluntarily and free of charge delivered. Under public administration, these materials are separated, transported, and disposed of correctly. This is an alternative for better management of these wastes, which are often improperly discarded due to negligence or a lack of awareness of the impacts on the environment and public health.

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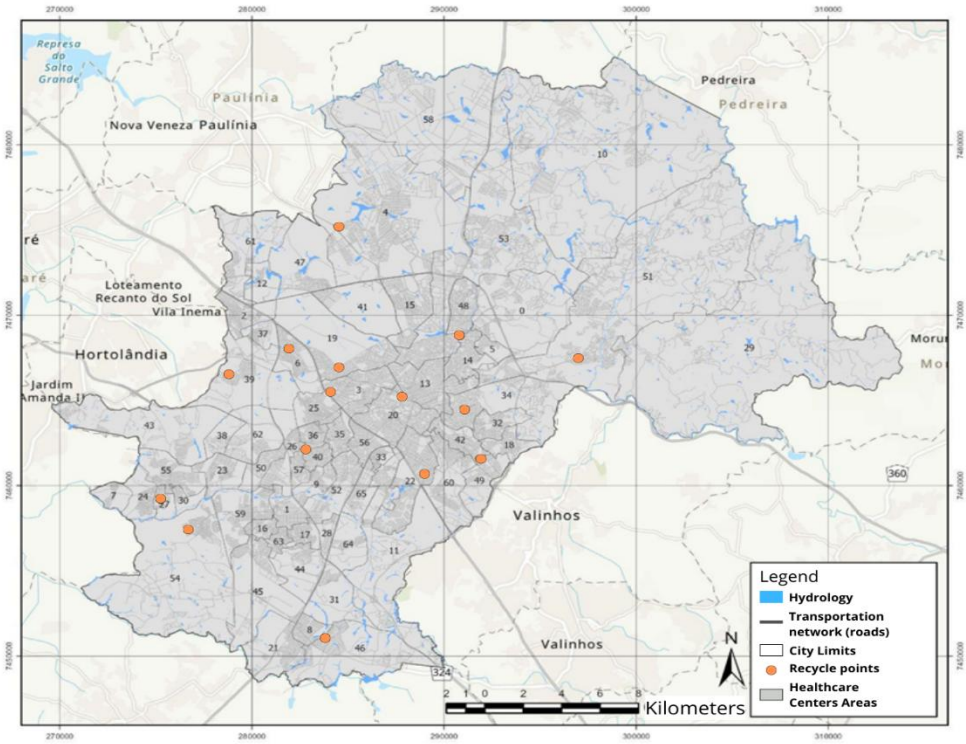
Figure 3 – Map of the Location of Ecopoints in the City of Campinas



Source: The authors

The city of Campinas has 16 Ecopoints spread across different regions, of which 15 are designated for receiving CDW, predominantly in the central region of the city and in southern neighborhoods such as Jardim Marisa, the Vida Nova housing complex, and Itajaí (Figure 3).

Figure 4 – Inadequate Handling of CDW in the Vila Moscou and Pq. das Universidades neighborhoods in Campinas

Source: Author's archives

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This restricted waste disposal structure (Figure 3) encourages illegal dumping in inadequate public locations such as parks, areas near watercourses, and public roads, as well as in private places, such as vacant lots and idle buildings (Figure 4). Associated with this situation, the dynamics present in urban space are of utmost importance for the analysis and understanding of the organization of the city, which, in turn, utilizes urban planning instruments (Ferreira, 2005) for this activity. Zoning[3]—a planning instrument—based on the interests of the owners of each lot, promotes the grouping of activities or common characteristics in the city, serving as a way to guide the property owner and minimize conflicts among them, while also limiting constructions and activities in the city and indicating the necessary infrastructure for each area.

Within a city's zoning plan, the instrument that indicates the relationship between the buildable area and the area of the lot is called the "coefficient of utilization" (CU). In the city of Campinas, the exemption from the onerous grant of the right to build was approved (Campinas, 2018), allowing the construction of buildings with a utilization coefficient greater than that stipulated by zoning, without the imposition of additional fees, thus facilitating real estate developments in the city and consequently reinforcing the waste generated at construction sites. Commercial verticalization projects generate demolitions and must hire specialized services regarding CDW, which should be sent to landfills.

There are greater risks of impact on drainage, intensifying diffuse pollution (Tomaz, 2006), and the effects of heavy rains, associated with high soil surface impermeability (Mota, 1999), contribute to the increased risk of clogging drainage networks, reducing the flow of rainwater and increasing flooding in the city. This situation is frequently experienced in Campinas, as evidenced by several significant flooding events: in January 2017, nine cities in the region required special attention due to flooding; in January 2020, twelve houses were flooded during a storm, resulting in loss of property and animals; and more recently, in October 2023, a severe storm caused widespread flooding, fallen trees, and damaged walls throughout the region (G1, 2017, 2020, 2023).

These recurring incidents demonstrate the city's ongoing vulnerability to extreme weather events and the challenges in managing urban drainage[4]. This results in the commitment of the city's dynamics, with problems in urban mobility and economic and human losses, especially with the increase in extreme weather events and intense rainfall. Furthermore, high soil impermeability, combined with irregular rainfall occurrences (Ribeiro *et al.*, 2006), intensifies the risk of stagnant water and contributes to the proliferation of *Aedes aegypti*, the dengue vector, making the urban environment a favorable setting for the spread of the disease, which has shown a concerning rate of cases in the city of Campinas.

The *Aedes aegypti* mosquito, a transmitter of diseases caused by viruses known as arboviruses, including dengue, has specific biological structures and conditions for its formation and proliferation. With a brief lifecycle, where the egg lasts about 7 to 10 days to become an adult mosquito, it breeds in locations with stagnant water, where the female lays eggs, and the

[3] According to Gaspar et al. (2013), zoning regulations serve as fundamental tools for organizing urban space and managing city growth patterns.

[4] Sodré (2012) discusses how urban water pollution from diffuse sources, including construction waste, can be exacerbated by inadequate drainage systems.

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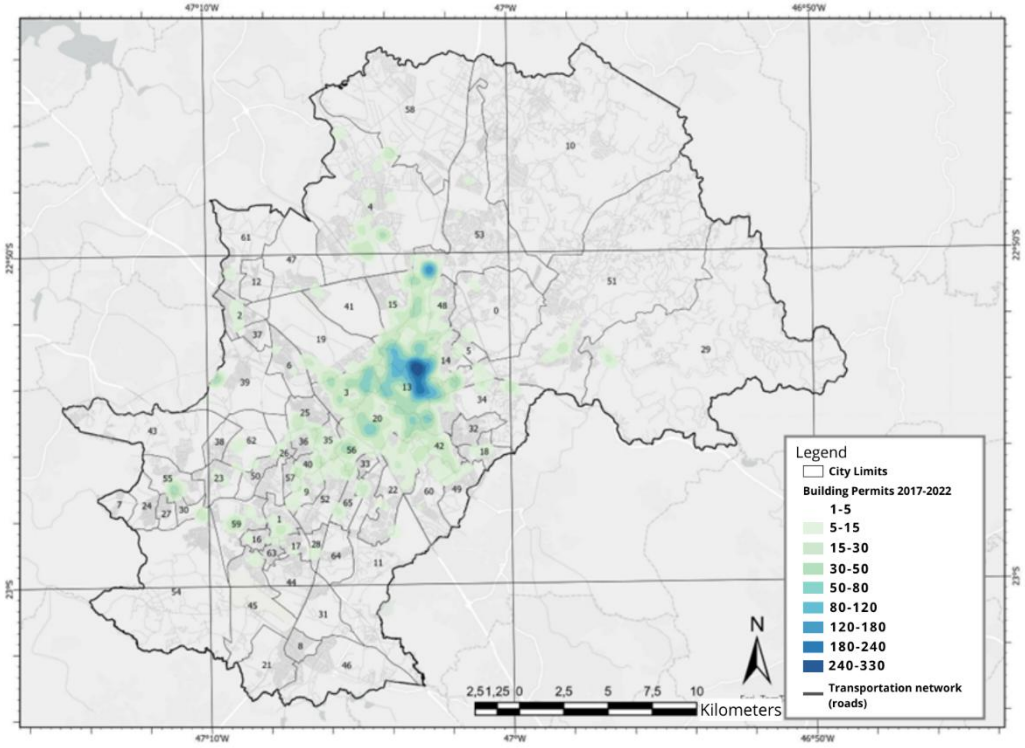
egg begins its development cycle until reaching adulthood, at which point it initiates the disease's vector process. Therefore, periods with rainfall incidence are favorable for the increase in disease cases, as any location with stagnant water can become a breeding site for the mosquito (Instituto Oswaldo Cruz, 2019).

RESULTS

MAPPING OF PERMITS AND DENGUE CASES

Figure 5 – Kernel Density Map for Total Construction and Demolition Permits in Campinas, SP (2017-2022)



Source: The authors

From the analysis of the Kernel density map, which shows the spatial distribution of construction and demolition permits in the Campinas region between 2017 and 2022, it is possible to observe that the concentration varies significantly among different areas of the municipality. Areas with higher permit density are represented in dark blue tones according to the legend, indicating a high concentration of permits, while areas with lower density are shown in light green tones, extending toward the outskirts of the municipality.

The highest concentration of permits is located in the central region of Campinas, and this concentration overlaps with the subdivision of health center coverage areas. Notably, the concentration is particularly evident in areas corresponding to the Central (9), Carlos Gomes (3), and Taquaral Health Centers (8). These areas exhibit a permit density ranging from 120 to 330 in total, as indicated by the map's legend. This suggests intense construction and demolition activity, possibly due to greater urbanization and economic development in these regions. In contrast, more peripheral areas, such as those corresponding to the Joaquim Egídio (5), Santa

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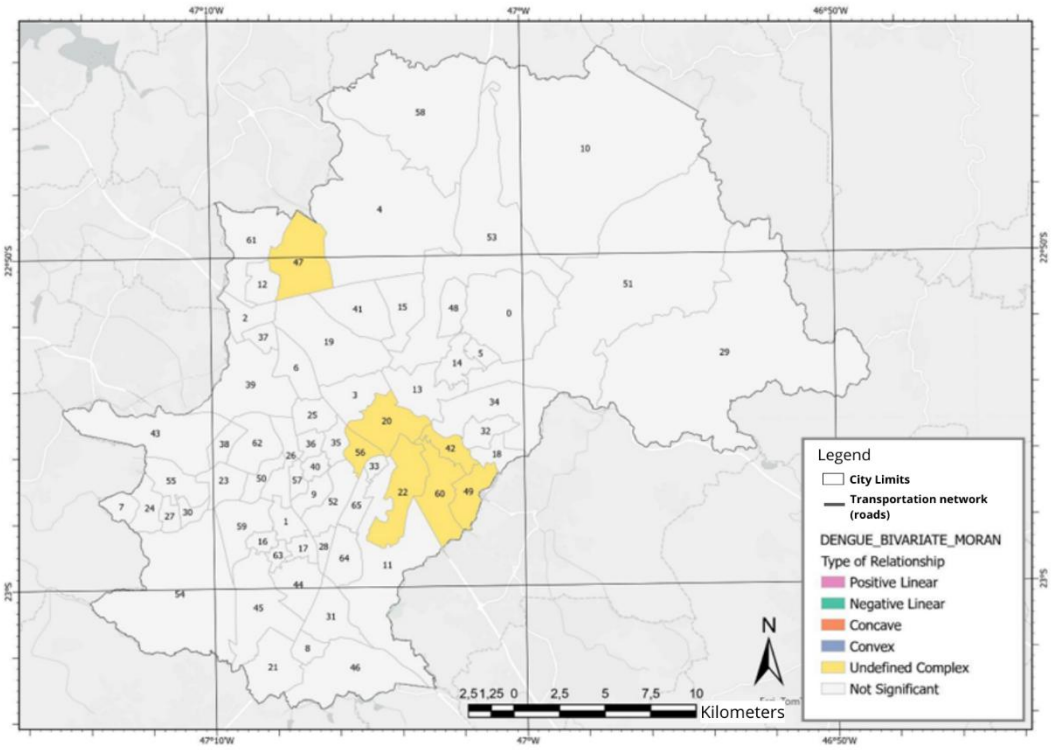
Rosa (21), and Satélite Íris II (23) Health Centers, show lower permit densities, ranging from 1 to 15. These areas, represented in light green tones, indicate less construction and demolition activity, which may be related to lower population density or reduced demand for new developments.

LOCAL RELATIONSHIPS OF THE BIVARIATE MORAN INDEX

Figure 6 – Spatial Analysis Map of the Bivariate Moran Index of Dengue Incidence in Health Center Coverage Areas and Number of Permits Issued



Source: The authors

Figure 6 illustrates the results of local bivariate relationships between dengue incidence and the number of construction and demolition permits in the city of Campinas, SP. The study covers the period from 2017 to 2022 and utilizes the local bivariate Moran index to identify areas where these variables are significantly correlated. The generated map uses colors to highlight the different types of relationships identified:

Undefined Complex, represented in yellow. This type of relationship is found in 7 areas (10.61% of the total), indicating a complex relationship that cannot be easily classified as linear or non-linear. The areas with undefined complex relationships suggest that there are additional factors influencing the correlation between dengue incidence and construction/demolition permits. These factors may include socioeconomic, environmental, or infrastructure variables that were not directly considered in the analysis. The areas with undefined complex relationships suggest that there are additional factors influencing the correlation between

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dengue incidence and construction/demolition permits. These factors may include socioeconomic, environmental, or infrastructure variables that were not directly considered in the analysis.

However, most of the municipality of Campinas is highlighted as 'Not Significant' on the map. This corresponds to 59 areas (89.39% of the total), where no statistically significant correlations were found between dengue incidence and construction and demolition activity. This result suggests that, in most regions, construction and demolition do not have a direct or significant impact on dengue incidence.

The results indicate that construction and demolition activity is not uniformly and directly correlated with dengue incidence in Campinas. Areas with undefined complex relationships suggest the need for further investigations to identify the underlying factors influencing these correlations.

For urban planning and public health management, it is crucial to consider these results when developing dengue mitigation strategies. Public policies should be adapted to address the specific factors in areas with complex relationships, while in areas without statistical significance, it may be necessary to focus on other health determinants.

CONCLUSION

The negative result of the initial hypothesis indicates that there is no clear correlation between the issuance of permits or the formalized construction activity and the incidence of dengue in the regions. This fact can be explained by several factors, among which we highlight the most relevant hypotheses.

Initially, we can consider the hypothesis that the activity of "formal" construction did not generate waste on a significant scale to establish large breeding grounds for the mosquito, in contrast to abandoned areas and possible open water reservoirs. Despite the construction activity in Campinas being conducted with low oversight and few sustainable management practices for the territory's scale, considering the limited number of ecopoints for waste collection. Moreover, there is an established pattern regarding the investigation process for the disease's proliferation, which mainly identifies cases based on the residential address of patients. This results in a responsive monitoring and surveillance situation that defines only the residential environment as responsible for breeding sites, which is an aspect that should be more critically examined regarding how we handle this disease that is reaching increasingly higher levels in the territories of Brazilian cities. The spatial analysis using the local bivariate Moran index provides a detailed view of the dynamics between dengue incidence and construction and demolition activity in Campinas. Although most areas do not show significant correlations, regions with undefined complex relationships highlight the importance of a multifaceted approach to understanding and addressing public health in the urban context.

CLOSING REMARKS

The study did not consider other factors that may influence the incidence of dengue, such as socioeconomic, environmental, or infrastructure variables. The analysis is based exclusively on construction/demolition permits and dengue cases. Other data, such as population density, land use, and environmental management practices, were not included, which may limit the

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complete understanding of urban dynamics. The research did not involve aspects of public administration regarding waste management, which can interfere with service quality, as since 2022 the City Hall has had temporary contracts due to the proposed Public-Private Partnership being challenged. Only in May 2024 was a bidding process finalized for 30 months of services, or until a new PPP is approved.

Overall, the management of solid waste, particularly construction waste in the municipality, reveals inadequate handling that relates to challenges in environmental sustainability and public health, notably for small generators, due to the low number of ecopoints and their distribution favoring formal areas, particularly established neighborhoods.

According to the data related to the permits, we did not find an increase in the number during the years when the payment for the onerous grant of the right to build was suspended, which conflicts with the intended objectives of stimulating the construction sector through the non-payment of the grant. It is worth noting that this period coincides with the coronavirus pandemic, which caused a reduction in many economic activities, and the construction sector was not halted, having been considered essential.

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