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Climatic and Socio-Spatial Aspects of the Occurrence of Dengue in Manaus AM, Brazil

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A B S T R A C T

The objective of this study was to assess the climatic, social, and spatial aspects of the occurrence of dengue in Manaus, state of Amazonas, Brazil, in the period of 2013 to 2015. A bibliographic survey was carried out and epidemiological, climatic, and socioeconomic data were collected. The theory and methodology of this study was based on the Urban Climate System, and Urban Environmental System. The number of cases of dengue differed in time and space because of the scales and processes in the recording of this disease. Climatic factors affect the development of dengue in Manaus, which presents two well-defined climatic seasons—rainy season (November to May) and dry season (July to October). The highest number of cases of dengue were recorded in the first semester of the year, under climatic conditions with distributed rainfalls (10 mm) with small intervals, maximum temperatures of 28°C to 34°C, with averages of 24°C to 29°C, and minimum of 22°C to 26°C, and relative air humidity of 70% to 97%. Large concentrations of rainfall with successive peaks were not ideal for the development of the main vector of this disease, the *Aedes aegypti* mosquito, accelerating or delaying its cycle. The data on the distribution of cases of dengue showed their socio-spatial aspect in the urban environment, with emphasis on areas with inadequate public water supply, garbage collection and disposal, and sewage treatment, as verified in the dengue belt—northeast, central and south regions of the city.

Keywords: *Aedes aegypti*, Risk, Urban environment, Amazon.

Aspectos climáticos e socioespaciais da dengue em Manaus, AM

R E S U M O

Este estudo objetivou analisar a dengue e sua relação com os aspectos climáticos e socioespaciais em Manaus nos anos de 2013 a 2015. Foi realizado um levantamento bibliográfico, assim como coleta de dados epidemiológicos, climáticos e socioeconômicos. A análise teve como fundamento teórico-metodológico o Sistema Clima Urbano (SCU) e Sistema Ambiental Urbano (SAU). As ocorrências de dengue se diferem no tempo e espaço, devido às múltiplas escalas e processos que se apresentam singularmente nos registros da doença. No contexto climático no desenvolvimento da dengue em Manaus, constatou-se que ao longo da temporalidade analisada, ficam explícitas duas sazonalidades climáticas, o período chuvoso (novembro a maio) e o período de estiagem (julho a outubro). As maiores ocorrências de dengue foram registradas no primeiro semestre do ano com as seguintes condições climáticas: chuvas distribuídas, de 10 mm e com intervalos pequenos em sua ocorrência, temperatura máxima de 28 a 34 °C, média 24 a 29 °C e mínima 22 a 26 °C, umidade (70 a 97%). Grandes concentrações de chuva (picos sucessivos) não foram ideais, fazendo que os aspectos climáticos influenciem no aceleramento ou retardamento do ciclo do *Aedes aegypti*. A distribuição das ocorrências de dengue se configurou na socioespacialidade do meio urbano, especificamente em estruturas com abastecimento de água, coleta de lixo e esgoto a céu aberto inadequado, como foi identificado no "arco" do risco de dengue, nordeste-centro-sul da cidade.

Palavras – chave: *Aedes aegypti*, Risco, Ambiente urbano, Amazônia.

Introduction

The development of dengue is connected to climatic variability, and social, economic, and environmental structures of urban areas. According to Rouquayrol (1999), the development of all diseases is somewhat potentiated by the climate through different factors.

Moreover, Lima *et. al* (2016, p. 385) stated that "the climate, combined with socioeconomic issues, contributes to the proliferation of epidemiological diseases".

The expansion of areas with risk of occurrence of dengue is connected to urbanization processes developed without proper social, economic, and political planning. These processes usually favor the spatial distribution and development of the main vector of this disease, the *Aedes aegypti* mosquito, and serotypes that causes this disease.

According to Costa (2009, p. 13):

> The spatiality of risks grows with the city; the activities in the city connect to one another, combining their risks, including several factors, such as industrial activities, landfills, and social conditions—areas with poverty, lack of infrastructure, and migrations).

According to Lima *et. al* (2016), the dynamics, distribution and accumulation of rainfall are connected to the occurrence of dengue in Recife PE, Brazil, and the ideal conditions for this disease to spread—average temperature of 26°C, maximum of 29.7°C and minimum of 22.2°C—occur in the rainiest months, which have the highest dengue case records. Socioeconomic aspects are also connected to the occurrence of dengue. Almeida *et. al* (2009) found significant correlation between houses connected to public sewage networks and occurrences of dengue.

The differences found in the effects of climatic and socio-spatial aspects on the development of dengue may relate to the spatial unit under analysis—municipality, neighborhoods, districts. Moreover, depending on the combination of data, the information on the reality may not be ideal, resulting in significant variations of results. Combining spatial and temporal data has great importance for studies on epidemiological risks, in this case, dengue.

Mendonça *et. al*. (2009, p. 258) indicate factors causing recurrence of dengue epidemics, such as:

> [...] inadequate urban infrastructure, increased volume of non-organic wastes, urban life styles, weak public health services and campaigns, and lack of awareness of the population on disease control.

According to Albuquerque (2012), information on the virus and its transmission is necessary for control this disease, including the habits and reproduction places of the *Aedes aegypti* mosquito, life styles of the society, and prevention measures.

The spatial approach in the health field includes the health situation of people and the establishment of the risk degree as the epidemiological vulnerability. Therefore, the analysis of the epidemiological risk is associated not only to the location of disease events, since their spatial distribution occurs to a greater or lesser extent depending on their spatial, economic, and political organization, and the suitability of the ecological environment for the reproduction of the mosquito.

The identification of urban structures of greater vulnerability to the occurrence of dengue is important in the decision making for the implementation of control measures of different magnitudes and impacts.

According to the Brazilian Ministry of Health (Ministério da Saúde, 2015), dengue had two major phases with successive epidemics in Brazil between 1990 and 2014. The first epidemics in 1998 and 2002 registered 507,715 and 696,472 cases, respectively. The second epidemics in 2010 and 2013 registered 1,011,548 and 1,452,489 cases, respectively. Moreover, epidemics of dengue over 10,000 cases in the state of Amazonas occurred in 1998 (13,894), 2001 (19,249), 2011 (61,986) and 2013 (17,832). According to the Manaus Health Department (Secretaria Municipal de Saúde, 2015), approximately 80% of these cases of dengue were reported in the city of Manaus, which had 18,583 in 2001, 55,879 in 2011, and 16,634 in 2013.

The incidence of cases of dengue in Manaus and its socio-spatial impacts increased, thus, the objective of this study was to assess the climatic, social, and spatial aspects of the occurrence of dengue in Manaus, state of Amazonas, Brazil, in the period of 2013 to 2015.

Material and methods

Spatial unit analyzed

The study was conducted in the city of Manaus (Figure 1), in 63 neighborhoods, divided into six administrative regions (Law No. 1402 of January 14, 2010). According to the census of 2000, Manaus had a population of 1,405,835, and in the 2010 census, it had 1,802,014 inhabitants.

The population in the north and east regions of Manaus (urban expansion regions) increased from 324,986 to 392,599 (east), and from 282,083 to 501,055 (north), from 2000 to 2010. In 2016, the estimated population of Manaus was 2,094,391 (Figure 2). The growth of Manaus generated occupations in fragile or vulnerable places of the city, "mainly by people from disadvantaged classes, due to the value of urban land and urban real estate speculation" (COSTA, 2015, p.75).

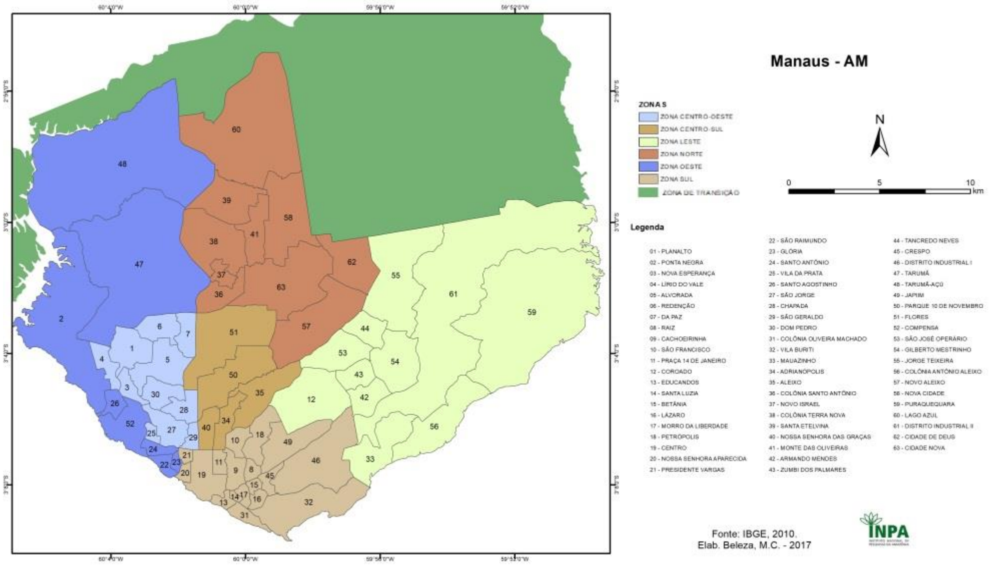

Figure 1. Map of the location of the spatial unit analyzed: Manaus. Source: IBGE, 2010. Produced by BELEZA, M.C., 2017.

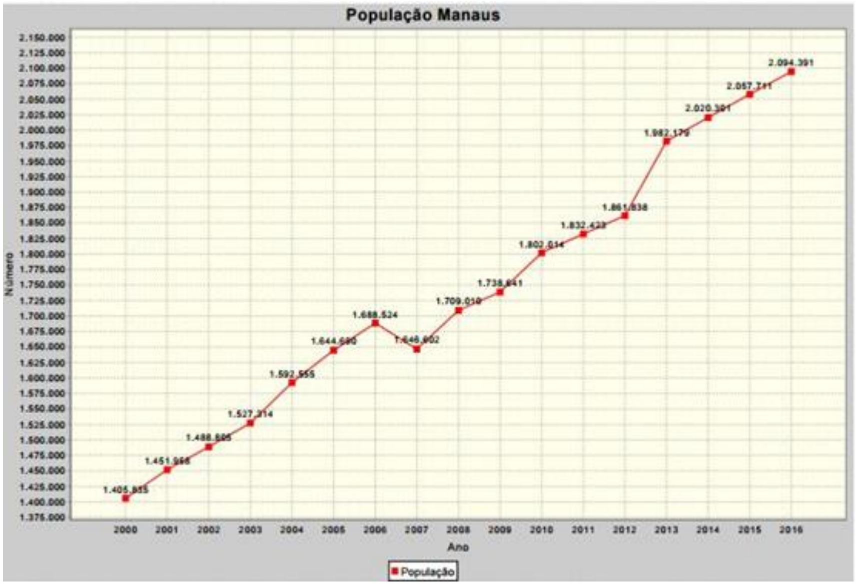

Figure 2. Census of 2000 and population in 2007 and 2012. Population estimates of the years 2001, 2002, 2003, 2004, 2005, 2006, 2008, 2009, 2011, 2012, 2013 and 2014 in the 1st of July of the respective year. Source: E-SIGA, 2017.

Data and procedures

The study was developed based on bibliographical survey on dengue, and collection and combinations of epidemiological, climatic, and socioeconomic data.

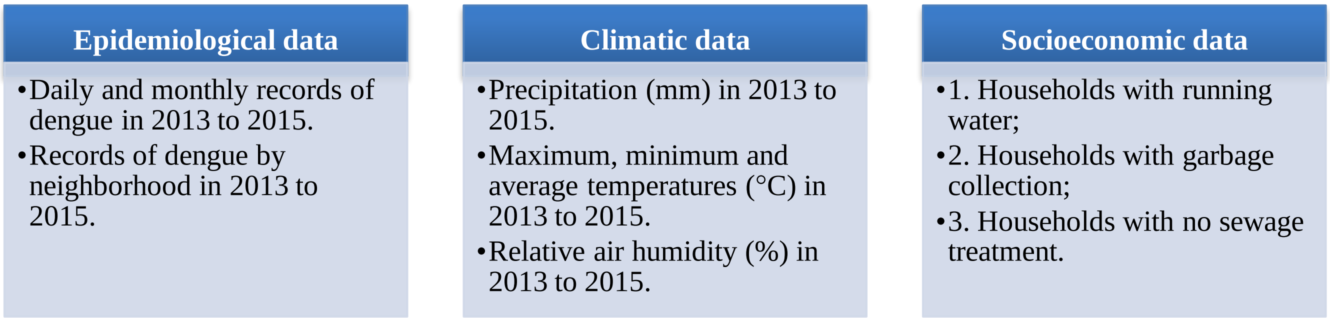

Figure 3: Research techniques and variables used in the study. Sources: SEMSA INMET (2016), and IBGE (2010), respectively. Produced by Beleza, M.C., 2017.

Regarding the epidemiological data, daily records of dengue containing addresses (street and neighborhood) were collected in the Manaus Health Department, and Department of Environmental and Epidemiological Surveillance (DEVAE/SEMSA).

Climatic data containing rainfall (mm), temperatures (maximum, minimum and average), and relative air humidity were provided by the National Institute of Meteorology (INMET/Manaus).

Socioeconomic aspects were evaluated using the variables demographic density, and number of households with running water, garbage collection, and no sewage treatment, whose data were provided by the Brazilian Institute of Geography and Statistics (IBGE/Manaus).

The information obtained were used to develop diagrams, graphs, and maps, using the Microsoft Excel, Google Earth Pro, and Arcgis 10.3 software, thus constructing the spatial mosaic of the distribution of cases of dengue in Manaus.

Analysis plan - Systemic method

The analysis had as theoretical-methodological basis the Urban Climate System proposed by Monteiro (1971), which seeks to understand the specific climatic organization of a city, taking the urban climate as a dynamic and adaptive system.

Monteiro (1971) established subsystems of human perceptions, namely Thermodynamic—Thermal comfort defined by heat, ventilation, and air humidity; Physico-Chemical—Air quality and water and soil pollution; and Hydrometeor—all meteoric forms, water (rain, snow, fog), mechanical (tornadoes), and electrical (storms).

The application of rhythmic climate analysis on a daily scale made possible to correlate climatic aspects (rainfall, temperatures, and air humidity) with dengue records of the years 2013 to 2015. The time interval of the climatic and dengue data established in the graph represents the lifecycle of the *Aedes aegypti* development (seven days).

According to Monteiro (1971, p.), the climatic rhythm can only be understood with the "joint representation of the essential elements of the climate in a short unit of time (at least one day)".

The quantitative expressions of the climatic elements in the rhythmic analysis are connected to their genesis and quality; parameters resulting from this analysis must be considered with their geographic location.

Based on the principles that guide the use and application of rhythmic analysis, and the complexity of the disease process, the study was also based on the Urban Environmental System proposed by Mendonça (2004), which addresses urban socio-environmental problems. This author confirms that this system "resume studies with the perspective of connecting physical-natural and human-social aspects to the local city and geography".

Results and discussion

Temporal distribution of dengue and climatic parameters

The climatic parameters affected the development of dengue in 2013 (Figure 4). The maximum temperatures in 2013 was 28°C to 36°C, with averages of 25°C to 31°C, and minimum of 22°C to 29°C. The temperature oscillation was constant, mainly from January to the first half of June, with maximum of 28°C to 34°C, averages of 25°C to 28°C, and minimum of 22°C to 26°C. The oscillation was low from the second half of June to the first half of December, with maximum of 33°C to 36°C, averages of 26°C to 29°C, and minimum of 23°C to 26°C.

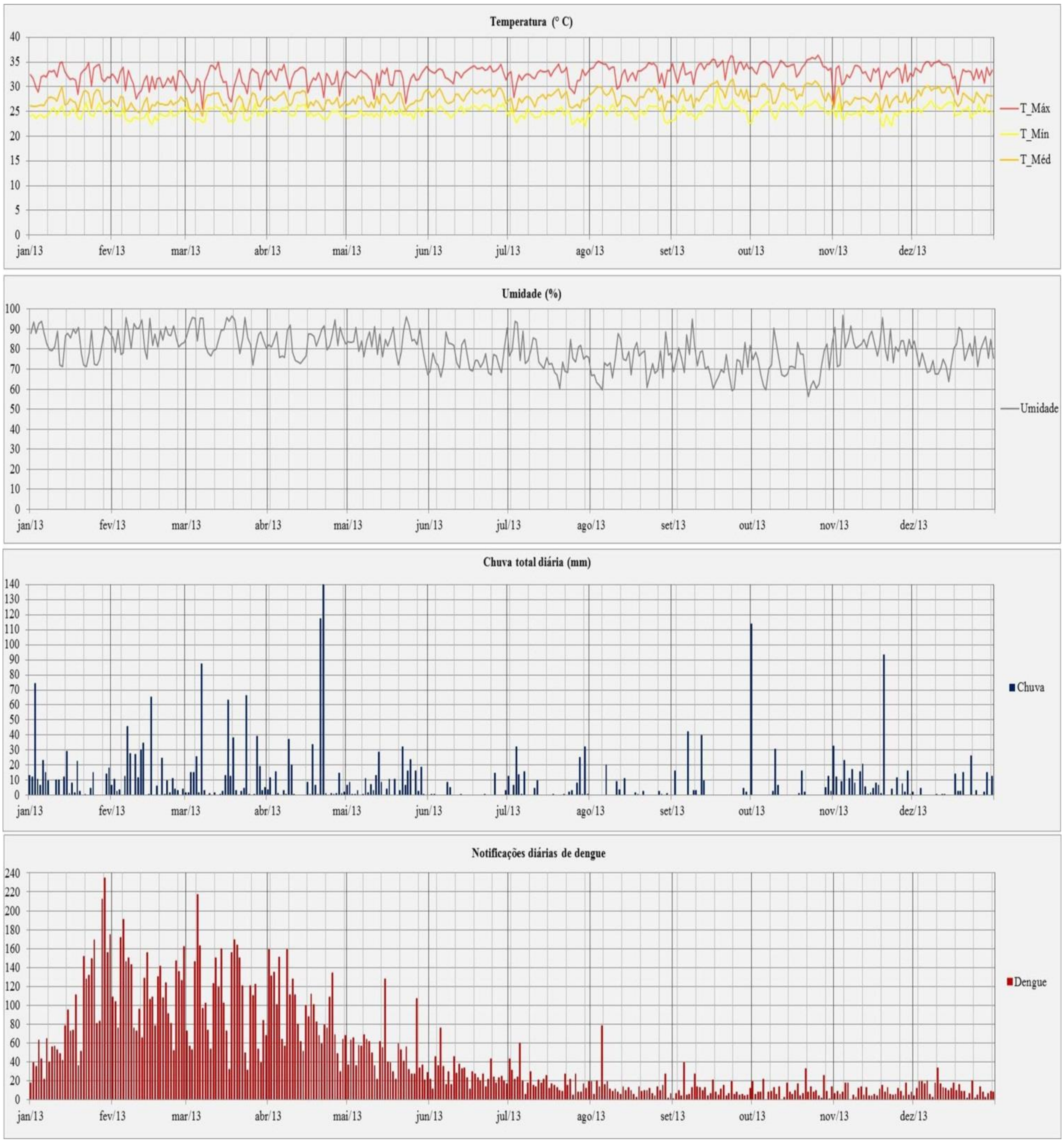

Figure 4: Rhythmic analysis on a daily scale with climatic elements—Maximum, Minimum and Average Temperatures, Air Humidity, and Rainfall—and records of cases of dengue in 2013 in the city of Manaus AM, Brazil. Source: INMET (2016) and SEMSA (2016). Produced by BELEZA, M.C., 2017.

The rainfall distribution and intensity in Manaus showed a rainy season with peaks of 90, 120 and 140 mm during November to May, and a dry season with drought of 10 to 100 mm during June to October. This variation also occurs for the variables temperature and air humidity. Regarding the number of occurrences of dengue, two periods were identified, the first in January to May and the second in June to December. The first week of July and August, reached 60 and 80 cases, respectively. The months with the most cases of dengue were January to May, during the rainy season—air humidity of 70% to 97%, and maximum temperatures of 28°C to 34°C, with averages of 25°C to 28°C and minimum of 22°C to 26°C. The occurrence of dengue decreases in the drought period, when the rainfall and air humidity decreases, and temperature increases (Figure 4).

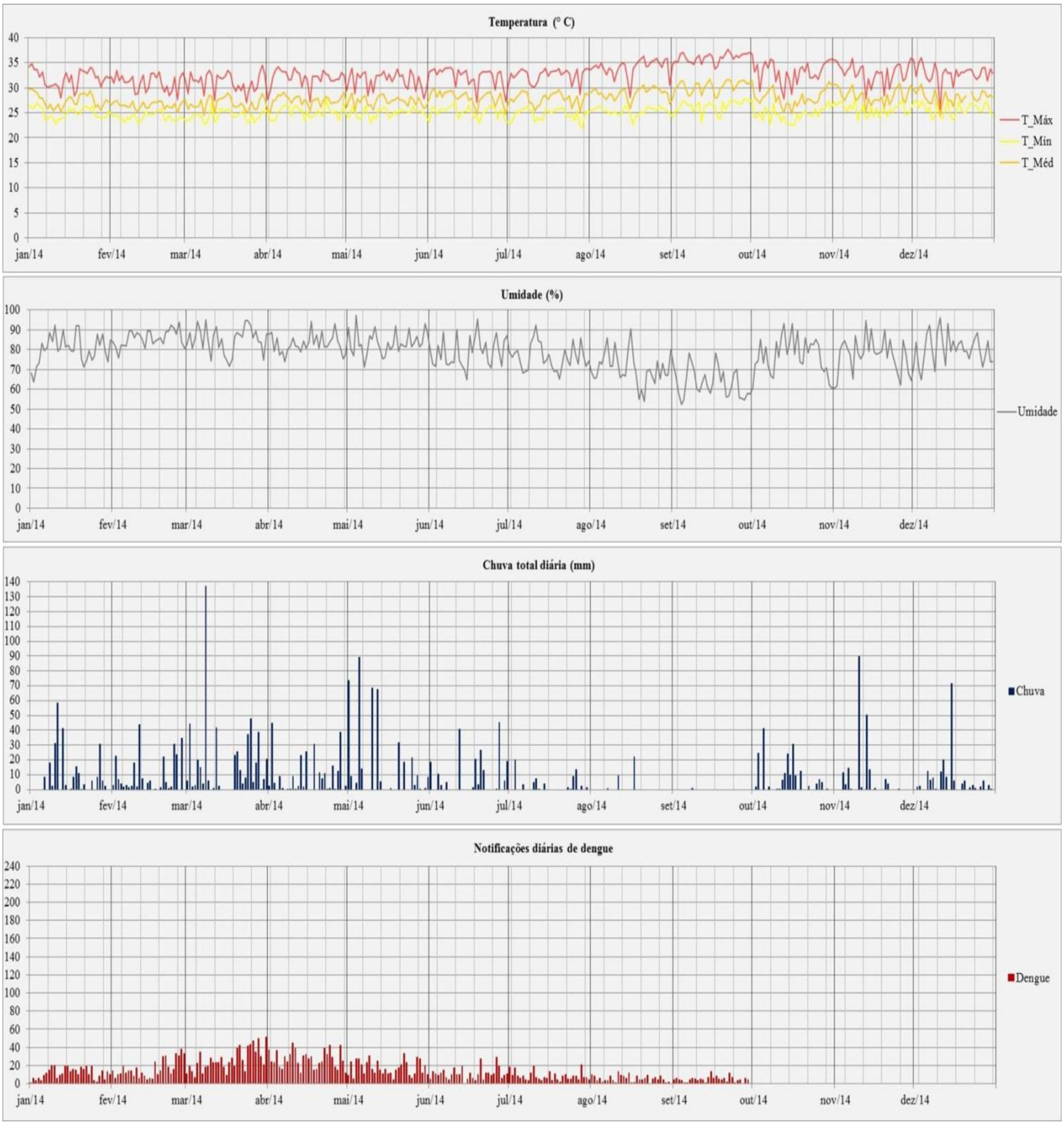

Figure 5: Rhythmic analysis on a daily scale with climatic elements—Maximum, Minimum and Average Temperatures, Air Humidity, and Rainfall—and records of cases of dengue in 2014 in the city of Manaus AM, Brazil. Source: INMET (2016) and SEMSA (2016). Produced by BELEZA, M.C., 2017.

Similar results of climatic variables and occurrences of dengue were found in 2014 (Figure 5), however, the number of cases of dengue was lower. According to the thermal, precipitation, and hygrometric aspects, 2014 was warmer than 2013, especially in July, August, September, and October in the dry season, which had the maximum temperatures of 33°C to 37°C, with averages of 25°C to 31°C and minimum of 22°C to 28°C.

The air humidity in the dry season of 2014 was 52% to 73%, however, September had the lowest air humidity (52% to 68%). The rainfall in the first half of July was 69 mm to 85 mm; August had rainfall recorded only from the second week; and October had concentrated rainfall in the second and third weeks, with 2 mm to 41 mm in the last week. The second half of August and September had no records of rains; September was the hottest month of the year.

The 2013 and 2004 rainy seasons were similar, except for the rainfall records. March and April 2013 had concentrated peaks of 68 mm to 88 mm and 110 mm to 140 mm, respectively. In 2014, these months had rainfalls of 25 mm to 137 mm and 45 to 74 mm, respectively.

The occurrence of dengue followed the climatic seasonality, the number of cases decreased mainly in June to September, with absence of records of this disease in the following months in the local health system (SEMSA); this result was also due to lack of information on the addresses of the patients.

The climatic aspects—air temperature, air humidity, and rainfall—in 2015 were higher when compared to 2014 (Figure 6). The dry season was marked by higher temperatures (33°C to 39°C) and the last three weeks of October were the hottest ones in this year, with maximum temperatures of 35°C to 39°C, averages of 29°C to 33°C, and minimum of 23°C to 29°C. The hygrometric variability recorded 50% in the last week of September and 45% in the first week of October; these were driest weeks of 2015.

Rainfall concentration peaks occurred in the last week of March, second and fourth week of April and second week of May 2015. The rainfalls in June to October recorded 10 mm each, and intervals of 2 to 4 weeks without rainfall. The drought period of 2015 was longer compared to 2013 and 2014.

Regarding the occurrence of dengue, 2015 had lower cases of dengue than 2013 and 2014, with 20 to 58 cases in March, 41 cases in the first week of June, 39 cases in the second week of September, 38 cases in the second week of October and November, and 22 to 40 successive cases in December. The other days of the year had together 10 to 20 cases of dengue.

Climatic parameters that potentiated the development of dengue were found in the three years evaluated. Occurrences of dengue predominated during the rainy season, however rainfall peaks were not favorable for their development. The occurrence of evenly distributed rainfalls during January 2013 (Figure 4), combined with the temperatures in this period—maximum of 28°C to 34°C, averages of 24°C to 29°C, and minimum of 22°C to 26°C—increased the number of cases of dengue. The cases of dengue decreased in the second week of March, from 220 to 100; the total rainfall in this period was 90 mm, temperatures increased in 1°C, and air humidity were between 70% and 76%.

A prolonged number of days without rainfall does not favor the development of the vector of this disease. The total rainfall in the second and third week of June reached 8 mm, with maximum temperatures of 31°C to 34°C, averages of 27°C to 30°C, and minimum of 24°C to 28°C. Concentrations of rainfall peaks, high temperatures, and air humidity of 68 to 88% in January 2014 also resulted in little development of dengue; February had more distributed rains, increasing the number of cases of dengue. More examples were found in 2015 (Figure 6); the first weeks of March had distributed rains and an increase of 58 cases of dengue, and the third week of March had a peak of 110 mm and a decrease in cases of dengue in the following week from 15 to 10 records.

The climatic parameters affect directly the development of *Aedes aegypti*, accelerating or delaying its cycle. However, is the type of urban infrastructure that generates the spatial distribution of dengue. According to Costa (2015), "Socio-spatial inequalities are shown by the infrastructure and organization of an urban space; thus, the contents of a landscape can characterize social, economic, and political inequalities related to the space, which is occupied in different and unequal forms—from upscale neighborhoods to slams".

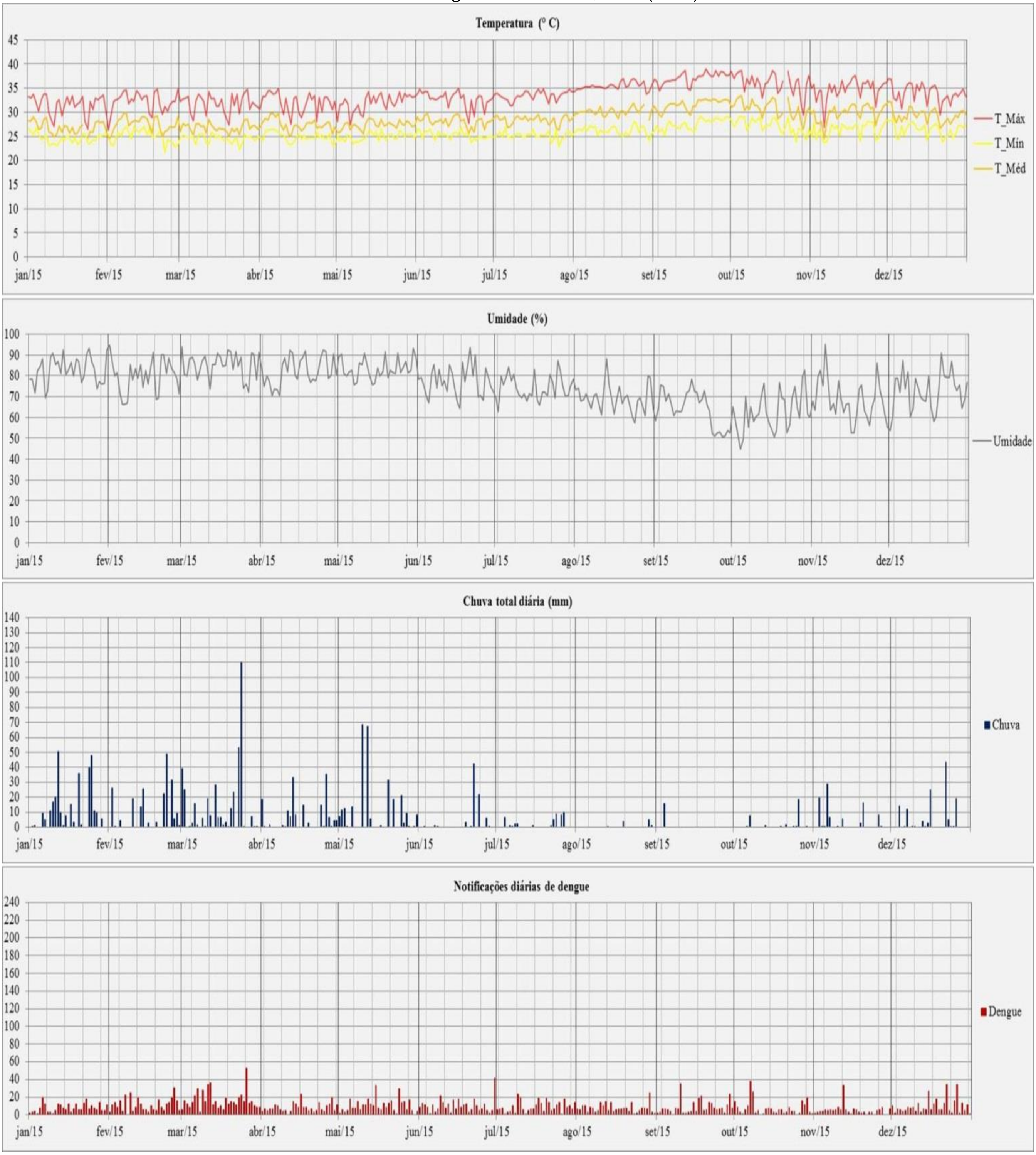

Figure 6: Rhythmic analysis on a daily scale with climatic elements—Maximum, Minimum and Average Temperatures, Air Humidity, and Rainfall—and records of cases of dengue in 2015 in the city of Manaus AM, Brazil. Source: INMET (2016) and SEMSA (2016). Produced by BELEZA, M.C., 2017.

Spatial distribution of dengue

The occurrences of dengue during the evaluated period based on a temporal scale (2013 to 2015) differed in time and space because of the scales and processes in the recording of this disease. Some cases were not accounted for due to the incorrect record or lack of information on the addresses of the patients in the local record system.

According to Corrêa (2007, p.63), scale is a social construction that presents three current meanings:

> Dimension, such as internal or external economies of scale; Cartographic, the relation between the object and its representation in letters and maps; and Conceptual, the idea that objects and actions are conceptualized on a given scale in which processes and configurations are specific and have their own scale of cartographic representation.

The homogeneity or heterogeneity of occurrences of a phenomenon will occur through changes of scales concomitantly to spaces and their respective structures, data, and information.

Figure 7 shows the spatial distribution of dengue in 2013, and 15,561 of the 16,688 cases of dengue identified using the neighborhood as spatial unit of analysis. The areas with the highest occurrence of dengue were the north (4,204), east (3,820), and south (2,482) regions.

The neighborhoods with more cases of dengue, in the class 779-2028, were Cidade Nova (2,028) and Jorge Teixeira (1,342), followed by those in the class 371-778, Alvorada (778), São José do Operário (633), Petrópolis (593), Novo Aleixo, and Compensa (519), Parque Dez (495), Cidade de Deus (464), Tancredo Neves (433), Flores (396), Coroado (388), and Zumbi dos Palmares (387).

The neighborhoods with less cases of dengue, in class 0-71, were São Raimundo (71), Distrito Industrial I (69), Colônia Oliveira Machado (65), Santa Luzia (49), Ponta Negra (47), São Geraldo 45), Glória (38), Nossa Senhora Aparecida (17), Gilberto Mestrinho (8), Lago Azul (7), Lírio do Vale, Tarumã-Açu, and Japiim (2), and Vila Buriti (0).

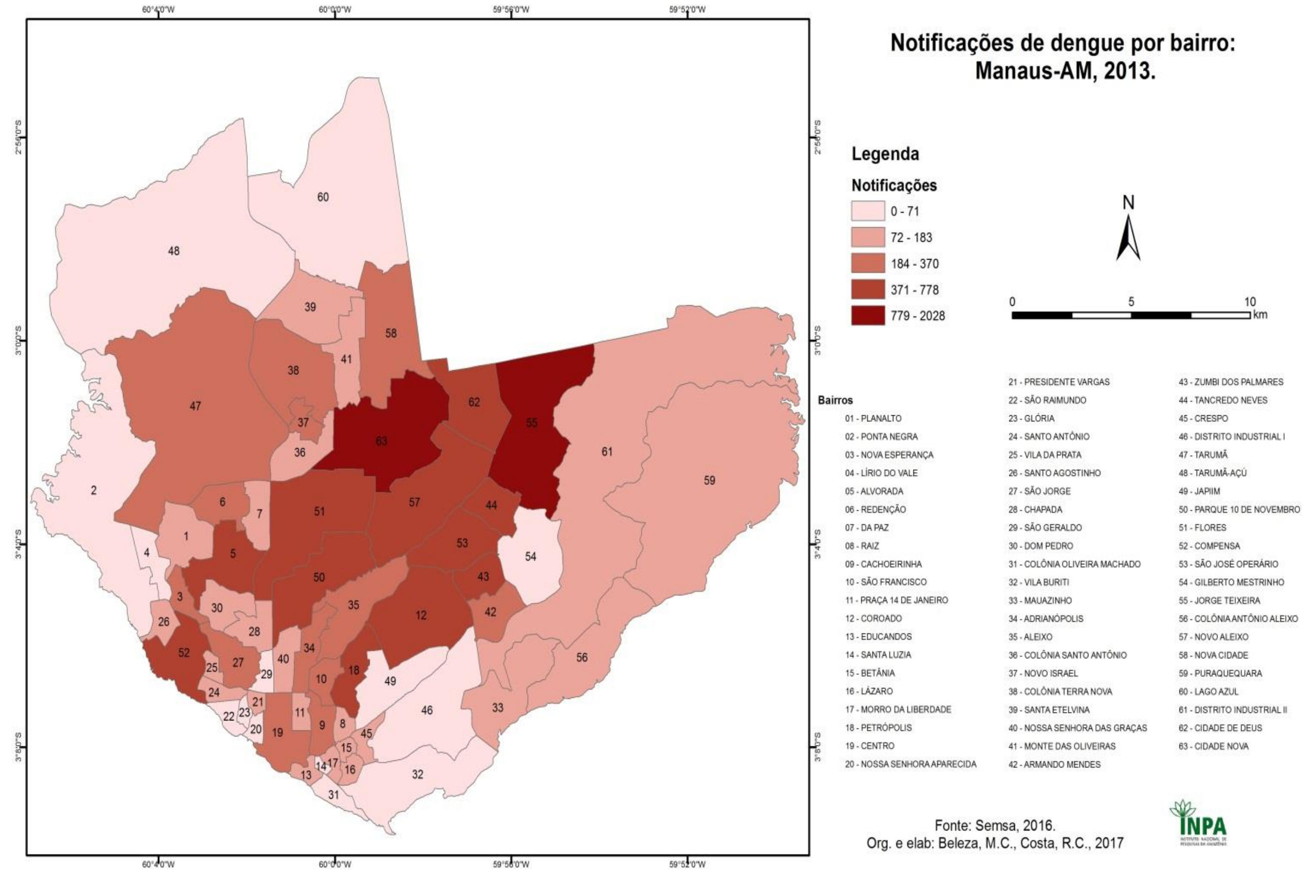

Figure 7: Distribution of cases of dengue by neighborhoods in 2013.

The spatial distribution of the 3,836 cases of dengue in 2014 (Figure 8) based on the neighborhood space unit showed 3,686 cases in the urban area. The north (953), center-west (953) and south (652) regions had highest number of cases.

The neighborhoods with more cases of dengue, in the class 262-404, were Cidade Nova (404), and Redenção (371). The neighborhoods in the class 137-261 were Alvorada (261), Jorge Teixeira (210), and Petrópolis (136).

The neighborhoods with less cases of dengue, in the class 0-25, were Colonia Santo Antônio and São Lázaro (25), Crespo (23), Presidente Vargas, Tarumã, and Raiz (21), São Geraldo (20), and Santo Agostinho (19), Vila da Prata (18), Betânia, Educandos, and Morro da Liberdade (17), Colônia Antonio Aleixo, and Mauazinho (16), Tancredo Neves (10), Santa Luzia (9), Lago Azul (8), Glória, and Tarumã-Açu (7), Nossa Senhora Aparecida (6), Distrito Industrial II (5), Ponta Negra (4), and Industrial District I (2).

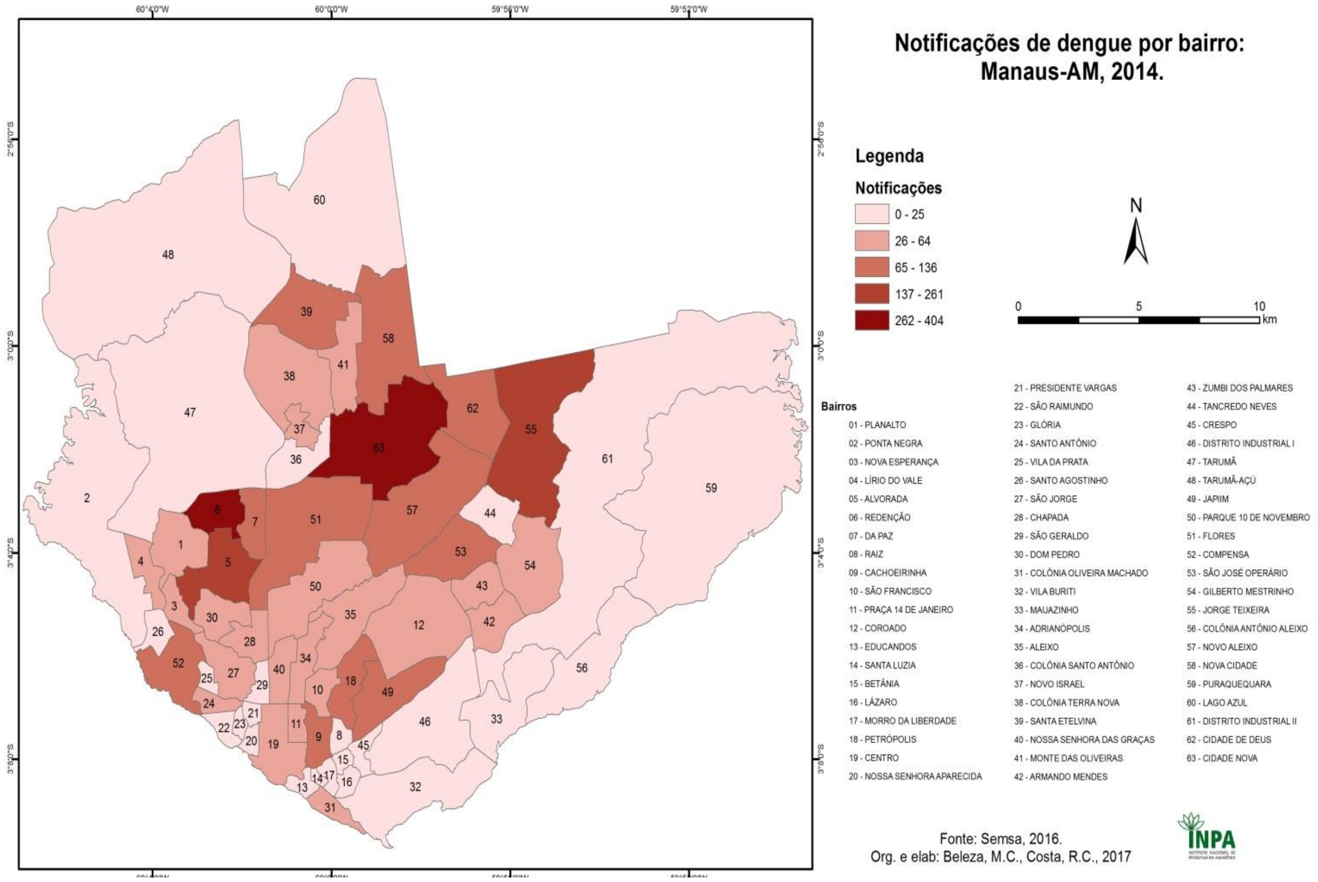

Figure 8: Distribution of cases of dengue by neighborhoods in 2014.

The distribution of the 3,424 cases of dengue in 2015 (Figure 9) according to the neighborhood space unit showed 3,355 cases in the urban area. The east (728), south (720), and north (665) regions had the highest number of cases.

The neighborhoods with more cases of dengue, in the class 149-235, were Cidade Nova (235), Jorge Teixeira (190), and Coroado (176). In the class 92-148, were Alvorada (148), Petrópolis (144), Japiim (136), Flores, and Compensa (131), San José do Operário (128), Novo Aleixo (122), Redenção (116), and Adrianópolis (112).

The neighborhoods with less cases of dengue, in the class 0-20, were Novo Israel (20), Morro da Liberdade (19), Ponta Negra and Vila da Prata (18), Chapada (17), Santo Antonio and Presidente Vargas (16), Colônia Antonio Aleixo (13), Colônia Oliveira Machado (12), Tarumã-Açu (10), São Raimundo (9), São Geraldo (6) and Mauazinho, Lago Azul, Glória, and Santa Luzia (5).

The spatial distribution of cases of dengue during the studied years defines the dengue belt in the northeast towards the center and south of the city.

The neighborhoods with more cases of dengue were Cidade Nova, and Jorge Teixeira. The disease risk in other neighborhoods, such as Alvorada, Cidade de Deus, Novo Aleixo, Flores, Petrópolis, and São José do Operário varied from medium to high in the evaluated period.

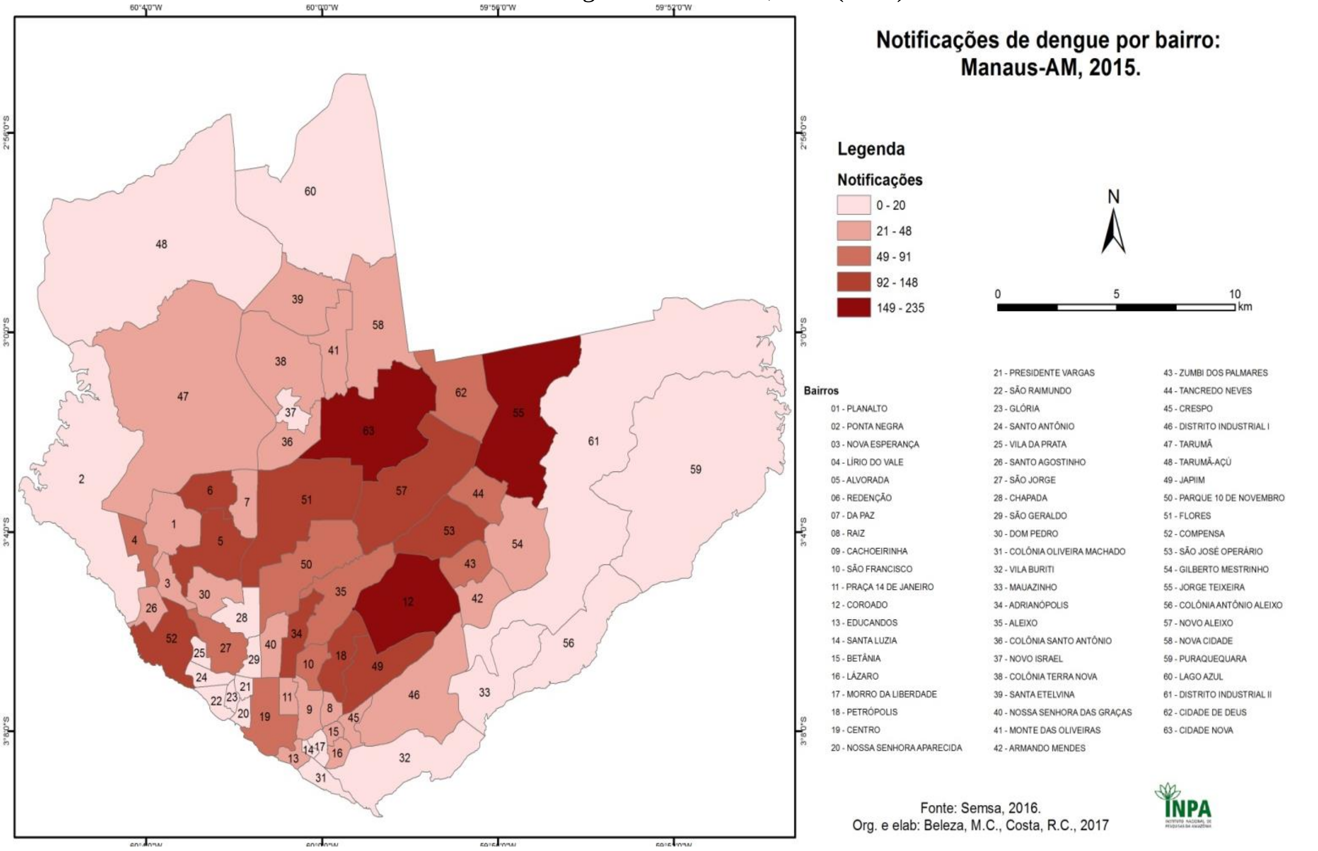

Figure 9: Distribution of cases of dengue by neighborhoods in 2015.

Social environmental indicators in the development of dengue

Social environmental indicators are important in the disease process, especially predictive models of dengue risk that identify the spread potential of dengue by considering environmental factors, such as climatic variables, and social factors, such as the characteristics of houses, public services, and transportation.

Only 75% of the households in Manaus in 2017 were connected to the public water supply network (Figure 10).

The neighborhoods with the highest percentage (91.57-98.91) of households with running water were in the south of the west region, and in the center-west and south of the city; the east, north, and north of the west region had low percentage of households with running water. These neighborhoods were Colônia Oliveira Machado (98,91%), Morro da Liberdade (98.29%), Santo Antonio (98.15%), Compensa (98.06%), São Raimundo (98.03%), Vila da Prata (97.96%), Glória (97.83%), Presidente Vargas (97.64%), Santa Luzia (97%), Crespo (96.46%), Japiim (96.20%), Educandos (96.19%), Praça 14 de Janeiro (95.97%), Alvorada (94.81%), Petrópolis (94.48%), Raiz (94.47%), São Jorge (94%), Cachoeirinha (93.83%), Betânia (93.63%), São Francisco (92.84%), and Lírio do Vale (92.71%).

The neighborhoods in the class 2.02-33.50 were Ponta Negra (33.50%), Distrito Industrial II (30.69%), Tarumã-Açu (28.39%), Colônia Antonio Aleixo (24.97%), Tarumã (23.59%), Lago Azul (4.59%), and Puraquequara (2.02%). The neighborhoods in the class 33.51-63.47 were Vila Buriti (66.47%), Colônia Terra Nova (61.05%), Adrianópolis (59.53%), Colônia Santo Antonio (53.45%), Parque Dez (59.52%), Jorge Teixeira (56.29%), Cidade de Deus (56.14%), Gilberto Mestrinho (49.17%), Monte das Oliveiras (45.44%), and Flores (40.44%).

Figure 10 defines a running water belt by the different percentages of households with running water. The inadequate public water services made the population seek for other sources of water to meet their needs. According to the IBGE (2010), these sources were individual and collective artesian wells, water storage containers, tanks, and trucks, as found in the neighborhoods of Cidade de Deus, Novo Aleixo, Flores, Parque 10, Alvorada, São José Operário, Zumbi dos Palmares, Coroado, Jorge Teixeira, Colônia Terra Nova, Tarumã, Adrianópolis, Aleixo, Cidade Nova, Nova Cidade, and Petrópolis. Most of the households in these neighborhoods have running water and presented the highest number of cases of dengue.

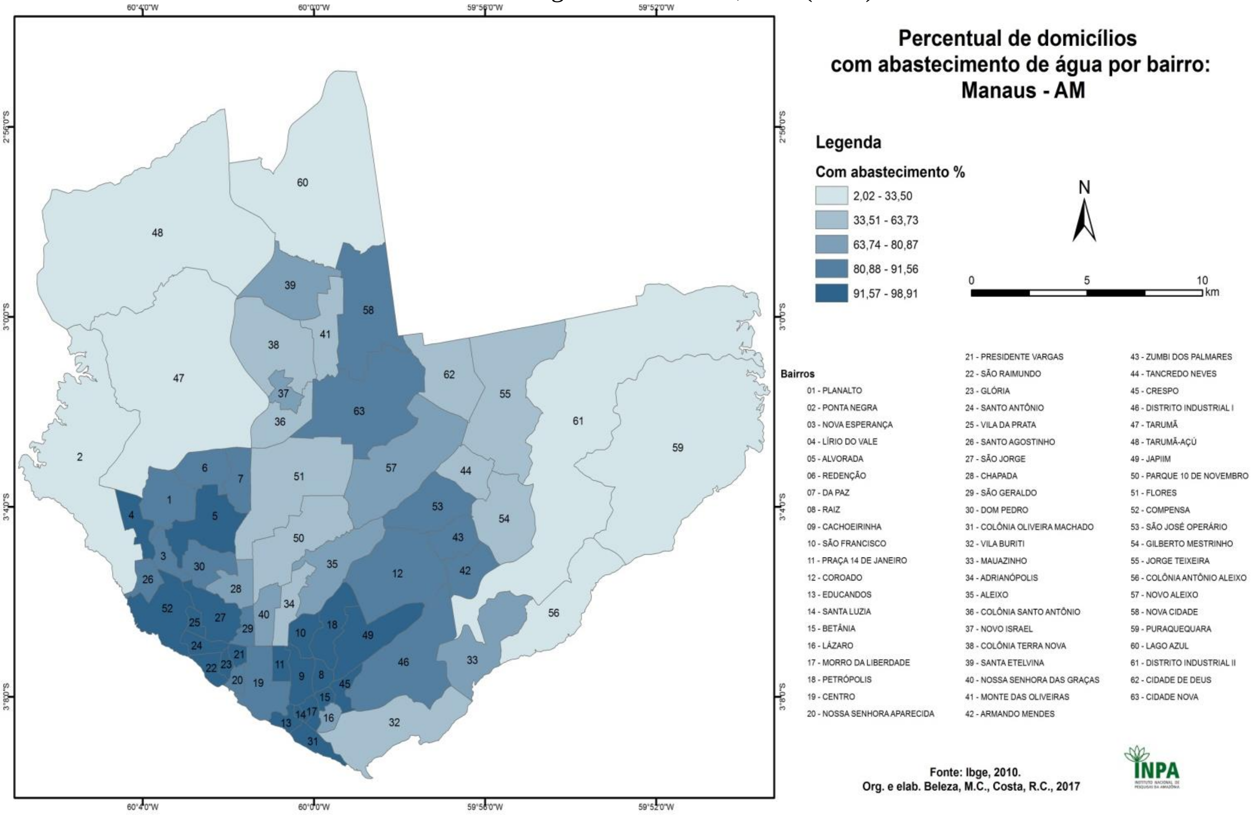

Figure 10: Percentage maps of households with running water by neighborhoods.

Figure 11 shows the percentage of households with garbage collection and coincides with some parts of the dengue belt and with locations with lower percentages of adequate water supply.

The neighborhoods with more correlations were Jorge Teixeira, Cidade de Deus, Tancredo Neves, São José Operário, Aleixo, and Gilberto Mestrinho.

Other neighborhoods (Lago Azul, Distrito Industrial II, and Puraquequara) that are not part of the dengue belt, also had inadequate services of water supply and garbage collection. Other forms of final waste disposal, such as burning, and informal landfills, are also found in Manaus.

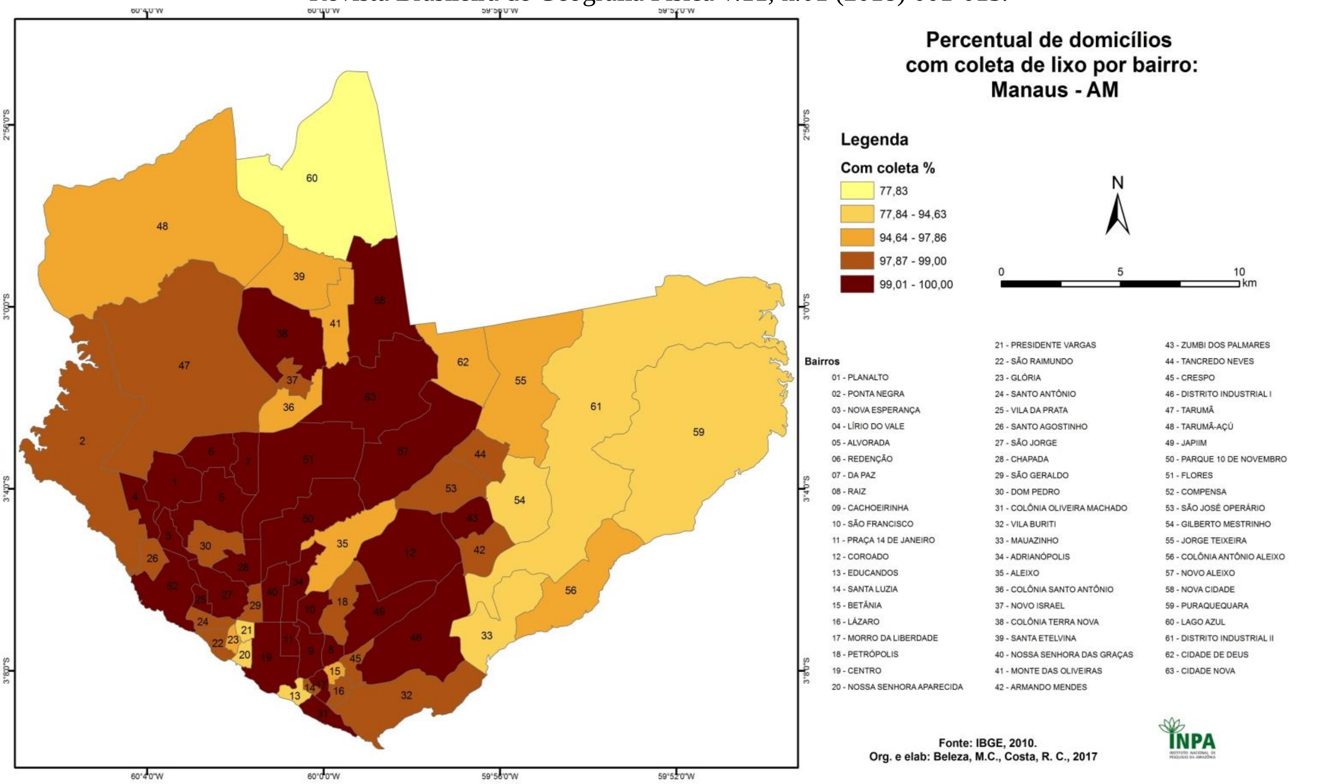

Figure 11: Map of the percentage of households with public garbage collection. Division by neighborhood.

Figure 12 shows the neighborhoods that presented the highest percentage of households with no public sewage treatment. These neighborhoods were also within the dengue belt, especially Novo Aleixo, Flores, Parque Dez de Novembro, São José do Operário, Coroado, Nova Cidade, Cidade Nova, and Petrópolis, except Cidade de Deus, Alvorada, Adrianópolis, and Gilberto Mestrinho, which have public sewage treatment.

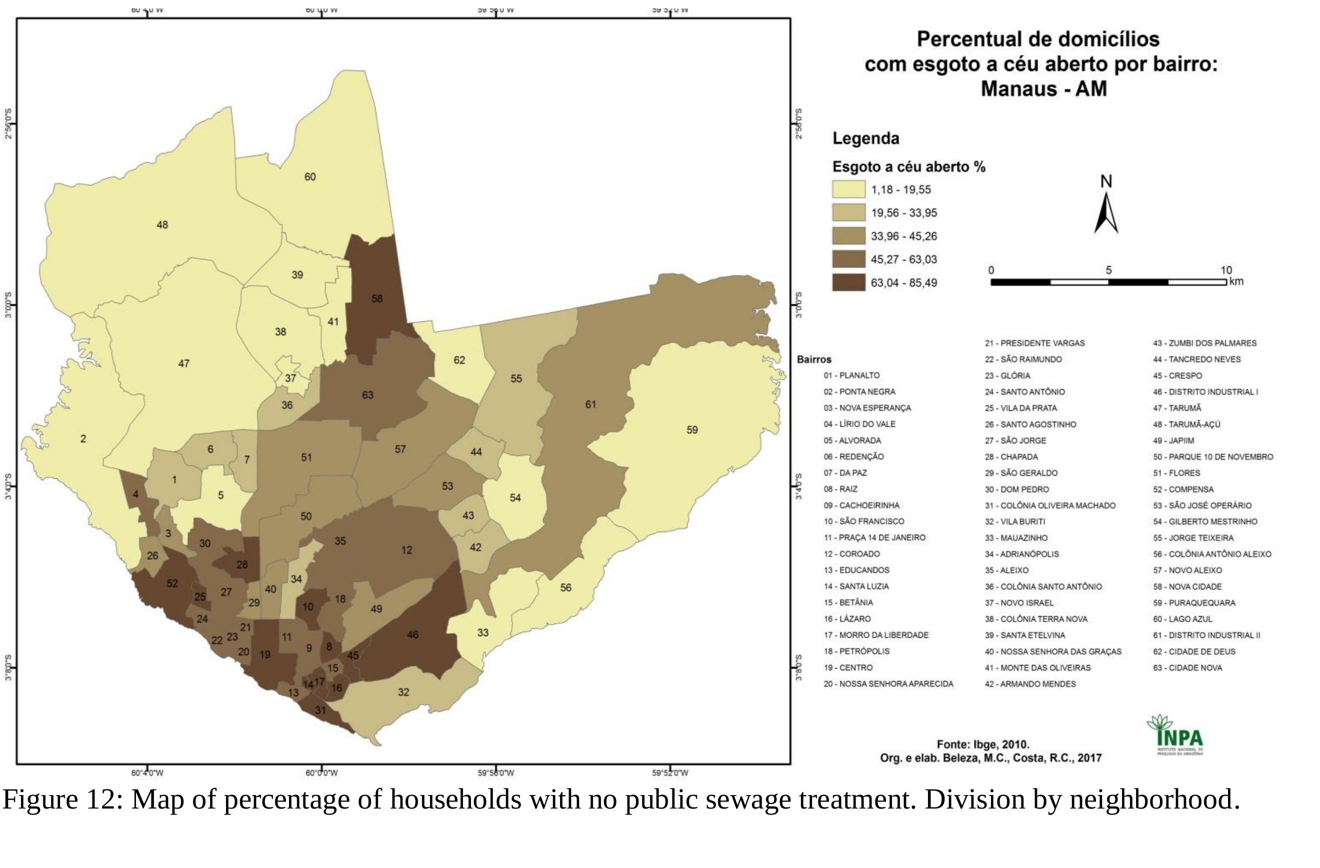

Figure 12: Map of percentage of households with no public sewage treatment. Division by neighborhood.

The neighborhoods Distrito Industrial II, and Vila Buriti did not integrate the dengue belt, but presented a significant percentage (33.96% to 45.26%) of households with no public sewage treatment.

Conclusion

The climatic parameters of Manaus throughout the evaluated period (2013 to 2015) showed two seasonal climatic conditions, a rainy season (November to May) and a dry season (July to October).

The highest occurrences of dengue were recorded in the first semester of the years, which presented the following climatic conditions: distributed rainfall of 10 mm with small intervals, maximum temperatures of 28°C to 34°C, with averages of 24°C to 29°C, and minimum of 22°C to 26°C, and relative air humidity of 70% to 97%. Large concentrations of rainfall with successive peaks were not ideal for the development of the main vector of this disease, the *Aedes aegypti* mosquito, accelerating or delaying its cycle.

The data on the distribution of cases of dengue showed their socio-spatial aspect in the urban environment with varied morphology inadequate sanitary conditions—public water supply, garbage collection and disposal, and sewage treatment. These conditions were found in the dengue belt—northeast, central and south regions of the city.

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