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DIAGNOSIS OF HEAT ISLANDS IN A NEIGHBORHOOD OF RECIFE AND POSSIBLE IMPACTS ON HUMAN HEALTH

[1,*]Eduardo Antonio Maia Lins, [2]José Mário de Araújo Cavalcanti, [3]Daniele de Castro Pessoa de Melo, [4]Wanderson dos Santos Souza, [5]Sérgio Carvalho de Paiva, [6]João Victor de Melo Silva, [7]Raphael Henrique dos Santos Batista, [8]Camilla Borges Lopes da Silva and [9]Giselle de Freitas Siqueira Terra

[1]Federal Education Institute of Pernambuco and Catholic University of Pernambuco, Recife, Pernambuco, Brazil; [2]Federal Education Institute of Pernambuco, Recife, Pernambuco, Brazil; [3,4]Technological Institute of Pernambuco, Recife, Pernambuco, Brazil; [5]Catholic University of Pernambuco, Recife, Pernambuco, Brazil; [6]Catholic University of Pernambuco, Recife, Pernambuco, Brazil; [7,8]Federal Education Institute of Pernambuco, Recife, Pernambuco, Brazil; [9]Catholic University of Pernambuco, Recife, Pernambuco, Brazil

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****Corresponding author:***
Eduardo Antonio Maia Lins

ABSTRACT

Currently, one of the biggest problems in urban areas is the disturbance of the characteristics of the atmosphere in the urban environment. The main reasons for this occurrence are the substitution of natural elements for artificial elements, such as buildings and soil waterproofing. The natural exchange of heat is prevented by the artificial medium and the characteristics of the region's microclimate are changed. The disorderly growth of urban centers brings discomfort when out of alignment with environmental conditions. The phenomenon known as Heat Islands is characterized by an increase in air temperature in areas formed by buildings and low tree density. This phenomenon is intensified when aligned with the high rates of atmospheric emissions. This work aimed to verify the occurrence of the phenomenon of heat islands, characterize its intensity, monitor its development, and suggest probable impacts on human health, having as reference the neighborhood of Boa Viagem, Recife, Pernambuco, Brazil. Measurements were made using temperature and humidity sensors at three points, with reference to an area with significant vegetation density, and other points located in the Boa Viagem neighborhood. The data were collected every half hour, recording them simultaneously in each location, and the measurement was carried out at a time of decrease in the ultraviolet index, between 14h and 16h. Data on dengue cases surveyed at work were provided by the Epidemiological Surveillance Sector of the Recife Health Department. Heat islands in urban centers have a higher incidence of dengue. Through the survey of data obtained at the State Health Department of the State of Pernambuco, it was noted that the infection rate is higher in these regions with a concentration of heat islands, which end up having the highest temperature in relation to other areas. The occurrence of dengue is linked to several factors, but the impact of the climate in this panorama has been gaining attention.

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INTRODUCTION

In the last centuries, a model of civilization imposed itself on the world, bringing industrialization, with its form of production and work organization, in addition to the mechanization of agriculture, channeling of water bodies, intense use of pesticides, occupation of protected areas and increasing urbanization, with a process of population concentration in cities (MARTELLI *et al*, 2019).

According to Silva (2015), developing countries, which have intensified their unrestrained pursuits for industrialization and economic development, began to experience, more frequently, manifestations of the environmental crisis, with accelerating indicators of malnutrition, rapid population growth and degradation of the natural environment due to anthropic actions. According to Milaré (2005), the environmental crisis caused by the increasing degradation of the environment is caused by an unbalanced relationship between human action and Nature, mainly in relation to the mistaken view of the current development model. With this great anthropic intervention in the natural environment and intense industrialization, another problem has been occurring as the release of gases that cause the greenhouse effect in the atmosphere (GHG) (MARTELLI *et al*, 2005). According to Sarricolea and Meseguer-Ruiz (2019), the urbanization process leads to changes, sometimes irreversible, in the territories and in their atmospheres, changing radiation balances, thermal characteristics; with the appearance of local microclimates; and, with the humidity and the winds. Therefore, the natural energy balance and the natural hydrological balance is disrupted. Urban climates comprise changes that can be, at times obvious, and at other times imperceptible, from a regional climate that is influenced and can be largely explained by urban design. This definition, according to Stewart and Oke (2012), reflects the changes observed in climatological elements such as temperature, relative humidity, wind, cloudiness, and precipitation, or in more complex indicators of bioclimatic comfort. These changes, observed in cities where there is a significant change from natural surfaces to other impermeable ones, for example. According to other factors involved, the phenomenon known as urban heat islands may arise.

In agreement with Sarricolea and Meseguer-Ruiz (2019), the theme urban heat islands are currently the most widely studied as a factor resulting from the changes caused in the climates of cities. Urban heat islands refer to the differences between the temperatures recorded inside the city and that of other non-urban environments. Note that only those urban and non-urban locations with similar characteristics in relation to altitude, distance, watercourses, and geographical factors should be compared. In recent years, several studies have shown that urban spaces are real poles of heat concentration during a much more comfortable non-urban environment, being characterized as what the scientific community calls the “Heat Island”. Cities contribute to changing the energy balance by modifying thermal and air quality standards, among others. The first observations of this phenomenon date back to the early 19th century, when Luke Howard, a chemist and meteorologist, made his first observations in London. Much more recently, the international scientific community has given great importance to the impact that megacities have on the global atmosphere, in addition to the effects on urban climate at a local and regional scale (MEIRELES, 2011). The tendency to pollute the atmosphere is prominent in developing countries, while it tends to stabilize in developed countries, as it is known that the driving forces of air pollution are economic growth, urbanization, energy consumption, increased transport, motorization, increase in the urban population (CHEN; KAN, 2008) and industrialization. In general, government officials tend to ignore the problem of air pollution by factors such as lack of knowledge, lack of adequate public policies, the public view that environmental control policies can be uneconomic, and the fact that the few who can suffer from such regulations have a strong political influence, generally greater than the many who could benefit from them (MCGRANAHAN; MURRAY, 2012). It is known that countries with more developed knowledge in the area result in stricter laws and lower pollution rates (FAJERSZTAJN *et al*, 2013).

The imbalance caused by the changes due to the unbridled growth of cities gives rise to the phenomenon of Heat Islands characterized by the increase in air temperature in areas predominantly formed by buildings and the low availability of tree units. When these factors are combined with the high rates of atmospheric emissions caused by cars and industries, we have an intensification of this phenomenon. Although it is a topic well known by the academic community and even by common sense, government officials fail to take a mitigating action to address this phenomenon that causes so much discomfort in the health of the population. It is relevant to study the relationship between climate and health, especially in view of global climate changes and in the prediction of their likely effects and vulnerabilities (SILVA; RIBEIRO; SANTANA, 2014). Dengue, for example, is a reemerging endemic or pandemic disease, which occurs in practically all tropical and subtropical regions of the planet. Silva-Voorham *et al* (2009). The countries located in these regions are more susceptible due to several conditions, including climate change, climate variability. Climate change has an increase of more than 2 billion in the number of people exposed to dengue and projections for 2085 suggest that about 5 to 6 billion people (50 to 60% of the global population) will be at risk of transmitting the disease (HALES *et al*, 2002). This work aimed to verify the occurrence of the phenomenon of heat islands, characterize its intensity, monitor its development and suggest probable impacts on human health based on studies on dengue, having as reference the neighborhood of Boa Viagem, Recife, Pernambuco, Brazil.

MATERIALS AND METHODS

Study Location: The study area is the city of Recife, capital of Pernambuco, Brazil, which is located between latitude 8º02’47 ”S and longitude 34º55’48” W from Greenwich, comprising an area of 218 km2. The region has a hot and humid tropical climate (As'), according to the Köeppen classification (2004), and has an annual average temperature of 25.4ºC and an amplitude of 2.8ºC, with an average annual relative humidity of 84% . The rainfall regime is characterized by two distinct periods: a dry or drought season, which lasts from September to February (spring-summer) and a rainy season, from March to August (October-winter), with an annual rainfall index average greater than 1,600 mm (ATLAS AMBIENTAL DO RECIFE, 2000). The sampling points were determined according to the anthropic characteristics due to the presence of cars and high concentration of buildings, in addition to the points of environments where there is the presence of tree vegetation and location close to the ocean. The measurement points are located within the city limits of Recife, encompassing 3 strategic points. Thus, 3 points were distributed:

Source: Google Maps (2019).

Figure 1. Studied location

- Point 1 - Located on avenue Conselheiro Aguiar, at the intersection with street Ribeiro de Brito (873’25.69” S; 34 ° 53’55.69” O).
- Point 2 - Located at street Navegantes (8 ° 7’29.73” S; 34 ° 53’52.08” O).
- Point 3 - Located at avenue Boa Viagem (8 ° 7’30.06” S; 34 ° 53’48.96” O).

MATERIALS AND METHODS

DHT 22 sensors were used to collect meteorological data, offering an accuracy of 2% for humidity and 0.5ºC for temperature with a time of 2 seconds for each collection. This device operates with temperature variations ranging from -45ºC to 80ºC and from 0-100% relative air humidity. This equipment is not waterproof and can easily be problematic. In line with this equipment, a digital thermohygrometer with external sensor was also used, which has an accuracy of 1ºC for temperature and 5% for humidity, operating a temperature range that goes from -50ºC to 70ºC, having a "time" of 10 seconds. However, DHT22 sensors work alongside an Arduino platform, requiring a circuit and software for it to perform its function in the field. The phenomenon of heat islands defined by the difference in air temperature observed within the urban area or in comparison with a rural area (FIALHO, 2012). The city of Recife does not have many fixed weather stations scattered around the city, which is why it was necessary to apply the methodology of mobile transects, as portrayed by Gartland (2011), which consists of following a predetermined route through a region, stopping at representative locations to obtain measurements using only one type of meteorological instrumentation, in this case, the sensor. Data on dengue cases surveyed at work were provided by the Epidemiological Surveillance Sector of the Recife Health Department for the analyzed neighborhood.

RESULTS AND DISCUSSION

All sensors were calibrated together, however errors may appear at the time of measurement regarding a gust of wind that can remove heat from the sensor giving a reading that does not characterize the heat islands because it is an event or even the fact that something or someone passing close to the sensor at the time of measurement can characterize an invalid reading. The measurements were performed manually, moving to the determined point and reading the sensor at the designated time on the clock, every 30 minutes, starting at 2 pm and ending at 4 pm. According to Alves (2017), usually in the morning, the temperature difference between urban and rural areas is generally smaller. This difference increases throughout the day as urban surfaces absorb solar radiation and re-emit it in the form of long waves heating the urban air. The analyzes carried out using thermohygrometers for the Boa Viagem neighborhood (Figure 2) resulted in variance according to the locations and times under study. From the graph of humidity versus the analysis period, it was observed that the behavior of each one of them is influenced according to the increase of urban concentration, either by the greater circulation of car traffic, the presence of buildings, the existence of arboreal and ocean environments. Both Street of the Navegantes and avenue Boa Viagem are close to the sea, with high humidity (about 90%) for the final analysis period, where avenue Conselheiro Aguiar is located a little further from the coast, its humidity the end was already 18% lower compared to the others.

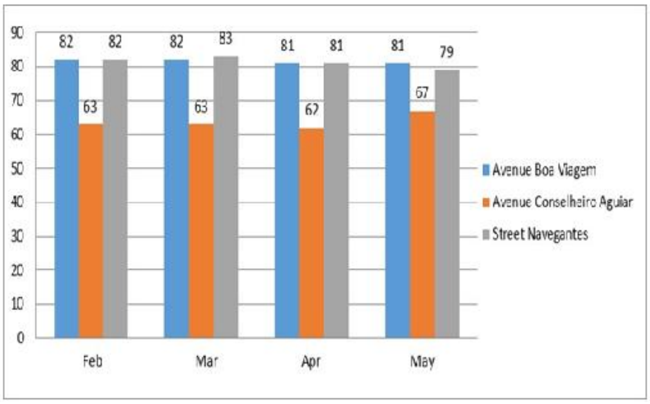


Figure 2. Humidity versus month ratio in the analyzed stretch of Bairro da Boa Viagem, Recife, Pernambuco, Brazil

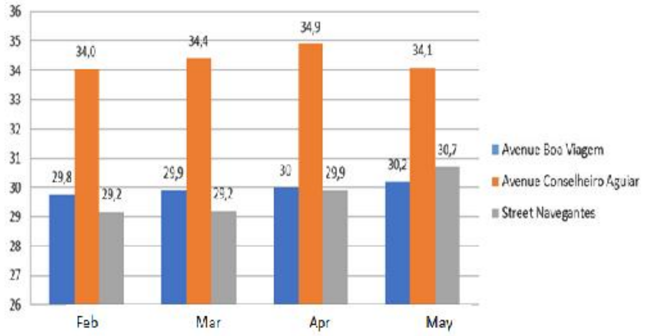


Figure 3. Temperature versus month ratio at Boa Viagem

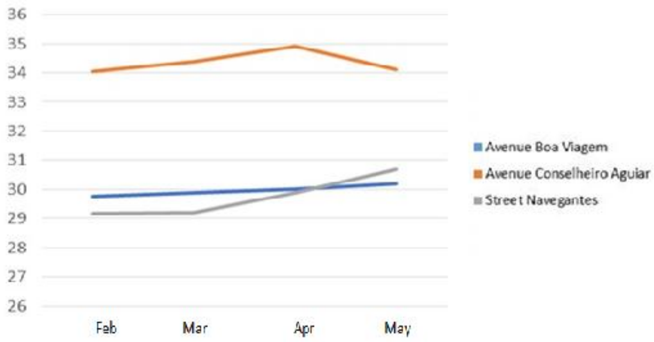
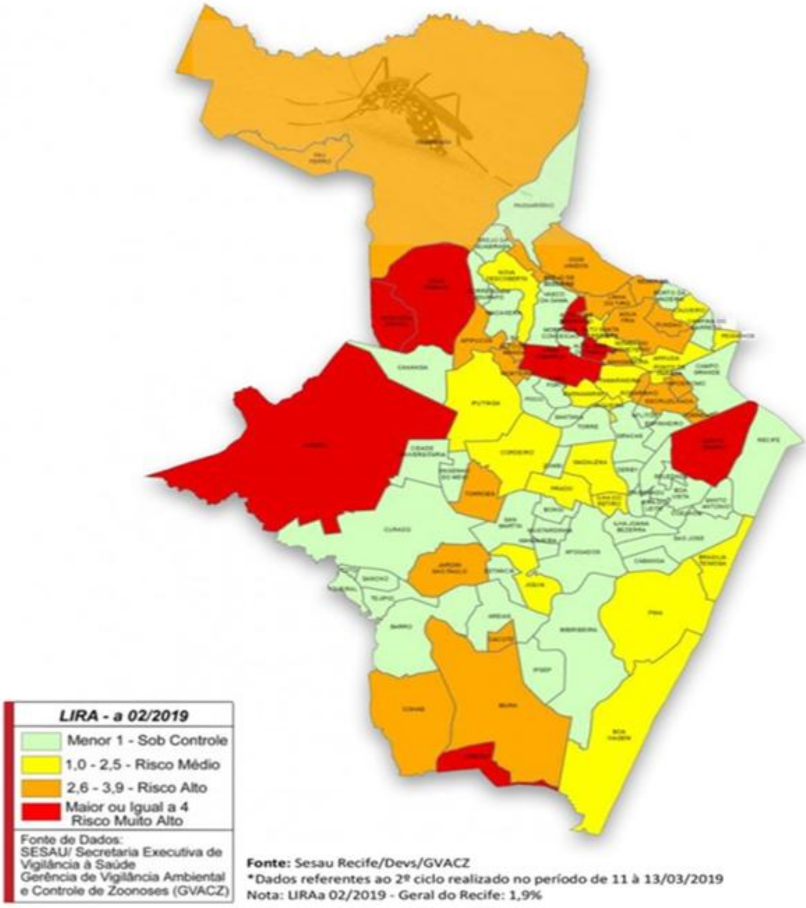


Figure 4. Temperature versus period relationship in Boa Viagem

From the graphs of variation in temperature and humidity, it was observed that the behavior of these variables is influenced according to the increase in urban concentration, the circulation of car traffic, the presence of buildings, the existence of arboreal environments and the ocean. It was noted that the months presented a similar average in terms of the collected humidity, the humidity was directly proportional to the time analyzed, with that, at 14 o'clock in the afternoon the humidity in both studied points presented a low percentage, and already for the time from 4 pm the humidity was higher at each point. In relation to Figure 3, of temperature versus the monthly period, there was a reduction in temperature over time, as the sunset goes on. Notably, the highest temperature was found for avenue Conselheiro Aguiar, which is farthest from the sea, where there is also a low incidence of vegetation cover and a high circulation of vehicles daily.



Source: City of Recife (2019).

Figure 5. Dengue Risk Map in the City of Recife

It should also be noted that urbanized regions are typically more efficient in storing solar energy, such as heat, inside their infrastructures, being able to absorb and store twice as much heat as non-urbanized areas as noted by Christen & Vogt (2004). According to studies carried out by Santos (2011) in his master's dissertation, from 1998 to 2010, for the same points studied in the city of Recife, based on the existing stations, there was also a temperature variation in the order of 1.5 ° C. Analyzing Figure 4, it is possible to observe the similarity of temperature and humidity in the points of avenue Boa Viagem and street of the Navegantes due to its geographical position and presence of arboreal areas and proximity to the ocean, unlike avenue Conselheiro Aguiar, which has characteristics distinct thermal and humidity conditions. Analysis of an entomological survey for 82 weeks using ovitrampa and mosquitrap, from September 2006 to March 2008, showed an important association between the number of positive eggs and the incidence of dengue, especially in the dry period (low rainfall). Honório *et al*, (2009) suggest that the average monthly temperature above 22-24 ° C is strongly associated with abundance of Ae. aegypti and consequently a higher risk of disease transmission. Miyazaki *et al* (2009) in a monitoring study using ovitraps conducted in Cuiabá, MT, between August 2004 and August 2005, one of the hottest capitals in the country (maximum average around 31º C), showed a significant correlation with the maximum, average and minimum temperature. According to Favier *et al*, (2006), the average number of pupae per positive container appears to be strongly associated with the average temperature. It was considered that the variable relative humidity of the air also favored the number of positive containers, Vila Planalto, Brasília. Similar results referring to São Sebastião, SP9, indicated that the highest values of temperature and relative humidity of the air were recorded between November and April, months also in which the highest Ae larval density indexes were observed Aegypti. Based on the studies carried out, it is noted that the incidence of Heat Islands may be directly associated with the increase in dengue. Heat islands are associated with increased temperature and reduced humidity, and, according to a survey carried out, it is observed that in the region affected by the heat island, the temperature and humidity are favorable to the event (Average Temperature of 34 C and Average Humidity 63%). The number of suspected cases of arboviruses increased by more than 100% in the state in the first half of 2019, compared to the same period in 2018 for the State of Pernambuco. The number of Zika notifications increased 197.8%, dengue records increased 123.1% and chikungunya records increased 115.9%, according to data from the State Health Department. The data recorded refer to the period between the 30th December 2018 and June 29, 2019. Also, according to the document, 56 deaths from arboviruses were reported in Pernambuco in the first six months of 2019. In the same period last year, there were 52 deaths, which is equivalent to an increase 7.6%. In the first half of 2019, 32,952 suspected dengue cases were registered. In the same period last year, the government reported 14,771 occurrences. The number of confirmed dengue cases reached 6,148 cases of dengue, 183 of chikungunya and 43 of zika, and 7,452 suspicions were ruled out. Analyzing the city of Recife, according to data from the Department of Health, 469 cases were reported, 423 of which were dengue, 39 of chikungunya and seven of zika in 2019. Of these figures, 73 cases of dengue and three of chikungunya were confirmed. When compared to the same period last year, there was a reduction of 30.5% in notifications and 74.5% in confirmed cases. Considering the 345 probable cases (notified cases, except those discarded), 50.72% are concentrated in the health districts IV (26.38%), VII (12.46) and VI (11.88%). It is noteworthy that the Boa Viagem neighborhood belongs to the health district VI, being part of the largest concentrations of dengue cases in the city of Recife. Data on dengue cases surveyed at work were provided by the Epidemiological Surveillance Sector of the Recife Department of Health, which recorded during the period of this study that about 142 cases of the disease were reported and only 91 confirmed in the Boa Viagem neighborhood. Of the 91 confirmed cases, 86 cases were of classical dengue and 5 of Chikungunya. Comparing the dengue data obtained for the analyzed neighborhood and the dengue data for the entire state of Pernambuco, it is noted that the percentage of incidence of the site represents 1.5% of the total value of confirmed cases. However, when comparing with data from the Metropolitan Region of Recife, this representation increases to 23%. Figure 5 represents a risk map published by the City of Recife (2019) related to the dengue situation in the entire city. The neighborhood of Boa Viagem, despite presenting a Medium Risk, for the period studied, has favorable conditions for the development of the disease, without considering the population variable, since the neighborhood includes the largest number of people in the city.

Conclusion

There is a difference in temperature and humidity when compared to areas that have a good plant density and areas that do not have tree units. The higher the concentration of buildings and the lower the plant availability of the place, the greater the incidence and intensity of the Heat Islands phenomenon, soon one realizes that in the Boa Viagem neighborhood there is an incidence of this phenomenon. An error is found to be attributed to the accuracy of the sensor, the climatic conditions of the measurement days and the process of operating the equipment itself. However, the measurement trend points to the presence of the Heat Islands phenomenon in the studied neighborhood. However, to characterize the intensity of the phenomenon, other work tools are needed so that a larger group of data can be gathered for greater accuracy of the average. The present research shows a small difference in the microclimate of the region caused by the Heat Islands in areas, within the same neighborhood, with and without vegetation, being also influenced by the flow of vehicles. The heat islands of urban centers can have an incidence of dengue, where the infection rate is higher in these regions with a concentration of buildings and asphalt and little trees, which end up having the highest temperature in relation to other areas.

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