

SPATIAL ANALYSIS OF HEAT INDEX IN THE URBAN HEAT ISLAND OF THE MUNICIPALITY OF JABOATÃO DOS GUARARAPES, PE

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Analyse spatiale de l'indice de chaleur dans l'îlot de chaleur urbain de la municipalité de Jaboaão dos Guararapes, PE

Mots-clés : îlot de chaleur urbain, sécurité thermique, climat urbain, Jaboaão dos Guararapes

Keywords: Urban Heat Island, Heat Safety, Urban Climate, Jaboaão dos Guararapes

Introduction

The urban heat island (UHI) is the most known effect of cities in the atmosphere (Matzarakis 2021) and is defined as the difference in temperature between urban areas and their surroundings (Oke *et al.*, 2017). It represents an increasingly frequent problem in large urban centers, where high temperatures are intensified, and heat-related syndromes are becoming more common in the population every year; this reality is exacerbated by climate change due to its impacts on global temperatures, particularly in tropical regions (IPCC, 2022; Nóbrega *et al.*, 2011).

Based on evidence that the UHI impacts involve social, environmental, and physical factors of the urban landscape (Moreira *et al.*, 2024), and that vulnerability to heat is strongly linked to socioeconomic factors in developing countries (Leal Filho *et al.*, 2018), this study aims to analyze the spatial distribution of the urban heat island in the municipality of Jaboaão dos Guararapes, Pernambuco, Brazil, and its consequences on the population of this city. To achieve this, the temperature exposure index was calculated according to the "Heat Index Alert Levels and Their Consequences for Human Health" (National Weather Service Weather Forecast Office, NOAA; Nóbrega *et al.*, 2011).

Jaboaão dos Guararapes is part of the Metropolitan Region of Recife, the capital of the state of Pernambuco, Brazil. It is located on the coastal region of Northeast Brazil, with a monthly average temperature above 25°C, under the climate type Aw (Köppen-Geiger, 1961). Its urban expansion is mainly influenced by the socioeconomic dynamics of the city of Recife, the center of the metropolitan region, resulting in a growing and intensive verticalization process and continuous conurbation between these municipalities.

1. Methodology

The methodological procedure encompassed the following steps: i) digital processing of surface temperature images from the Sentinel-3 mission. These images were registered on March 23, 2023, 12:00, and were made available on the Copernicus Open Access Hub platform of the European Space Agency (ESA); ii) calculation of surface temperature from these images using the ESA SNAP platform, through the transformation of the pixel's signature into surface temperature in Celsius degrees; iii) calculation of the exposure index by normalizing the surface temperature image using the 'Fuzzy Membership' tool in ArcGIS Pro, generating the final raster of the exposure component; and iv) mapping the exposure index according to the "Heat Index Alert Levels and Their Consequences for Human Health" (National Weather Service Weather Forecast Office, NOAA).

2. Results and Discussion

Table 1 shows the heat risk warning classes, classified as 'No Warning', 'Caution' and 'Extreme Caution', while Figure 1 displays the map of the calculated heat exposure index for the municipality of Jaboaão dos Guararapes. The highest index values were identified along the municipality's coastline and in isolated urban clusters to the north and northwest. The heat exposure index decreased as it moved away from the coast, with the lowest values in the extreme west of the municipality.

Table 1. Heat Index Alert Levels and Their Consequences for Human Health
(National Weather Service Weather Forecast Office, NOAA; Nóbrega *et al.*, 2011), adapted by the authors.

Warning Levels	Heat Index	Heat Syndrome (symptoms)
Extreme Caution	32,1° - 41° C	Possibility of cramps, exhaustion and heat stroke for prolonged exposure and physical activity.
Caution	27,1 - 32° C	Possible fatigue in cases of prolonged exposure and physical activity.
No Warning	Less than 27° C	No syndrome.

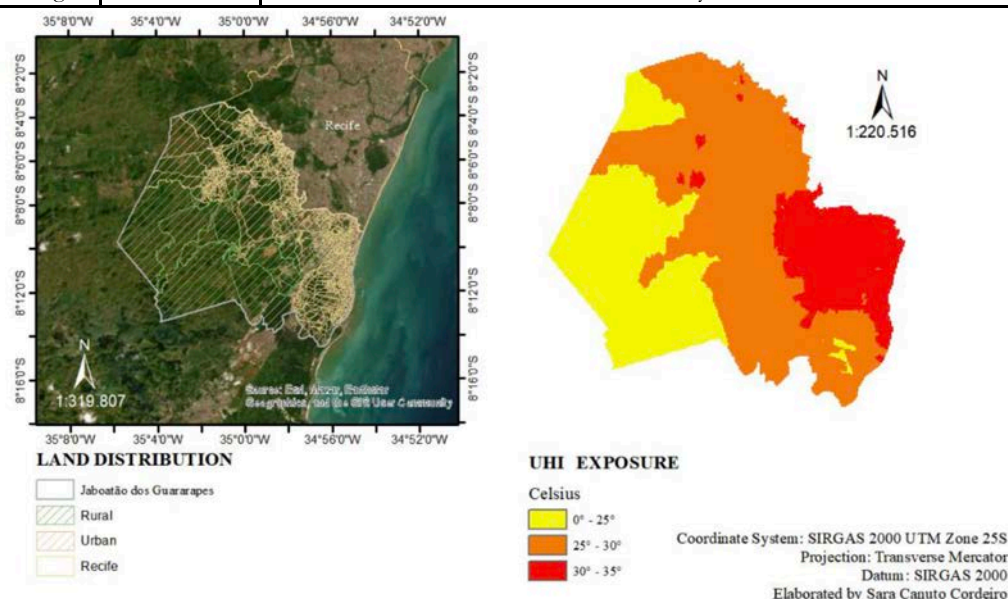


Figure 1. Location map and Urban Heat Island (UHI) Exposure Index of the municipality of Jaboatão dos Guararapes, Pernambuco, Brazil.

The heat index significantly increases as it approaches the coastal areas of Jaboatão dos Guararapes, including affluent neighborhoods. This trend indicates a higher exposure to heat in these areas, despite the influence of maritime surface. This is crucial for urban planning, especially when considering adaptation measures to ensure the well-being of the population in more affected regions. Strategies such as increasing green spaces, implementing urban cooling systems, and raising awareness of heat protection practices can be particularly relevant in these locations to ensure a healthier and more livable environment. Urban growth can intensify the heat island effect, raising local temperatures due to the replacement of natural areas with urban surfaces like asphalt and concrete. This change in land use contributes to heat retention and the reduction of vegetation, exacerbating climatic conditions. In this case, where urban expansion occurs closer to the coastal areas, with a concentration of affluent neighborhoods in the coastline, the influence of maritime climate may be altered. Intensive urbanization in these areas leads to higher temperatures due to the modification of the natural characteristics of the environment.

Conclusion

The spatial differences due to urbanization of the municipality of Jaboatão dos Guararapes influences directly on how the heat is increased in the non-rural areas of the city as shown by the heat index spatiality, resulting in aggravated and health-threatening temperatures on the regions nearest the coastline attributable to the effects of the urban heat island.

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