From Climate and City: Bioclimatic Comfort in Velásquez, Porto

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Introduction

In Porto, urban heat island effects are intensifying due to dense construction, soil sealing, a lack and fragmentation of green spaces, increasing thermal discomfort (Lopes et al., 2022), climate injustice and vulnerability. The lack of vegetation undermines the city's ecological resilience and adaptive capacity in the face of the climate crisis and the growing frequency of extreme events. Community green spaces are essential to promote social cohesion, well-being, and climate adaptation (Oliveira & Pinho, 2010).

In this context, Nature-Based Solutions (NBS) are critical to addressing these challenges and strengthening Porto's urban resilience, helping to mitigate heat and improve thermal comfort. Strategies like green spaces and green roofs enhance the city's adaptation to climate change (Augusto et al., 2020).

Aim

- *Identify areas of thermal discomfort in a dense urban neighborhood using spatial analysis and remote sensing techniques;*
- *Investigate local variations in heat stress and discomfort, promoting adaptive strategies for greener and more resilient urban planning through the integration of ecosystem services and community needs at the microscale;*
- *Promote spatial justice by highlighting environmental inequalities and proposing adaptive strategies at the microscale*

Methodology

The methodology is based on spatial and socio-environmental analysis, using geographical systems to detect vulnerable neighborhoods exposed to thermal discomfort and extremes. Remote sensing techniques such as satellite imagery and a Digital Surface Model (DSM) to map patterns of heat and solar exposure. A comprehensive literature review on Nature-Based Solutions, ecosystem services, and resilient urban planning provided the principal of comfortable and greener cities.

To complement the spatial analysis, a field study was carried out to observe local microclimates and collect data on air temperature (°C) and relative humidity (%) in sun-exposed and shaded areas. Also considered community dynamics, land use, and potential green infrastructure. Together support a critical reflection on environment equity, urban resilience, and the role of NBS in promoting healthier, more livable urban environments on a microscale.

Results

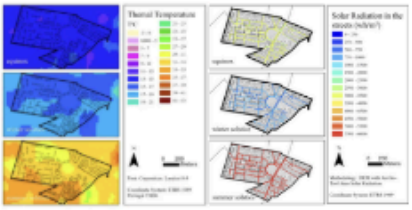
The study area presents reduced airflow, with regional wind only in winter, contributing to pollutant and heat accumulation in summer and cold retention in winter.

A thermal anomaly was identified: winters are mild, summers are hotter and unstable (1–5°C above average, reaching 35°C), and spring/autumn temperatures are moderate (20–25°C). Surface temperatures are elevated, especially in densely built-up central and southern zones with limited vegetation.

Green space coverage is sparse, with only three public parks and one small equipped garden, and in some areas, spontaneous measures causes local temperatures to rise by up to 4–8°C. More than half the area is occupied by apartment buildings, whose residents have limited access to quality green spaces, unlike those in detached houses with private, well-maintained greenery.

Additionally, noise sensitivity along the Fernão Magalhães axis remains a concern, as reported by both local residents and visitors.

These findings reveal stark environmental and spatial inequalities, reinforcing the need for just and inclusive strategies, particularly for apartment residents disproportionately affected by heat stress, pollution, and lack of greenery.



F1- Superficial Temperature during the Year, Spring, Winter and Summer, in celcius degrees in Velásquez Area// Font: Copernicus Landsat

F2- Solar Radiation during the Year, Spring, Winter and Summer; measured inwatts per square meters in Velásquez Area // Method: DEM with ArcGis Tool Area Solar Radiation.

F3: Green areas in Private or Public typology, Road corridors with permanent tree cover and Local Ecological Corridor in Velásquez Area// Font: Imagery and Google Earth Pro (on the right are some examples of the surrounding area)

Conclusion

The results highlight the urgent need for integrated, equitable strategies that address environmental injustice and enhance urban resilience at the microscale. Underused urban spaces offer a valuable opportunity for multifunctional intervention: combining recreational use with retention basins to mitigate flood risk, especially in low-permeability areas.

In dense neighborhoods with limited green access, proximity-based ecological solutions: such as shaded gathering areas, aromatic gardens, vertical farming, and sensory parks: can enhance inclusion and One Health principals.

Areas exposed to direct sunlight exhibit surface temperatures 4–8°C higher than shaded surroundings, reinforcing the importance of shade provision, tree canopy expansion, and nature-based cooling strategies.

Integrating urban ecological corridors is essential for improving biodiversity, ecosystem connectivity, and public health.

Nature-Based Solutions, urban ecology, and spatial analysis are fundamental to creating healthier, fairer, and climate-resilient urban neighborhoods.

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CERTIFICADO

Certifica-se que **Daniel Rodrigues Pinto** participou no **IJUP'25 – 18.º Encontro de Investigação Jovem da Universidade do Porto,** que decorreu nos dias 7, 8 e 9 de maio de 2025.

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