

A Geospatial Approach to Urban Project Management and Resilience: Promoting Climate Shelters in the Municipality of Braga (Portugal)

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ABSTRACT

The escalating impacts of climate change necessitate innovative urban planning and management strategies to safeguard communities against extreme weather events. This study explores the creation of climate shelters areas with the use of technologies, namely a mobile application, within the urban center of Braga, Portugal. Utilizing Geographic Information Systems (GIS) project, we mapped areas of extreme heat risk, assessed urban vulnerabilities, and proposed adaptive strategies to enhance resilience through of a climate shelters mobile application. This paper sets out to explore the importance of creating climate shelters in the urban center of the city of Braga, namely within the city's ring road, assessing both the challenges posed by climate change and the opportunities that arise from implementing adaptive solutions. This type of study aims to adopt innovative and sustainable approaches in the city of Braga and other territorial areas, as well as more resilient in the face of the climate challenges of the 21st century.

KEYWORDS

Geotechnologies, Internet of Things (IoT), Geographic Information Systems (GIS), Climate Shelters, Extreme Heat, Cities Management, Resilience, Sustainability

1. INTRODUCTION

Climate Change (CC) represents a growing challenge for urban environments, where extreme weather events, particularly heatwaves, increasingly impact public health, infrastructure, and societal resilience (Khan et al., 2023; Kumar, 2021; Pinto et al., 2024; Vidal et al., 2024). Urban Heat Island (UHI), driven by dense infrastructure and limited green spaces, amplify these effects, disproportionately affecting vulnerable populations (Lopes et al., 2024; Pinto et al., 2024).

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This study therefore proposes the implementation of climate shelters in the urban center of Braga (Portugal), based on the extreme heat risk mapping used in the methodology proposed by Lopes et al. (2023). Braga, a city located in the northern region of Portugal, faces these challenges head-on due to its unique combination of urban density, historical buildings, and climatic conditions.

Climate shelters are designated spaces designed to offer relief from extreme heat while contributing to urban resilience. These areas are physical safe zones but also critical components of a comprehensive urban climate adaptation strategy. By addressing both immediate thermal comfort and long-term resilience, climate shelters align with global efforts to create sustainable and livable cities in the face of climate uncertainties (Lopes, Silva, et al., 2025).

Inspired by international examples, namely the case of Barcelona (Spain), where more than 300 public spaces have been designated as climate shelters (Amorim-Maia et al., 2023; Martín-Vide & García, 2024), the aim is to promote solutions for adapting to extreme weather conditions in the city of Braga, namely by creating a Geographic Information Systems (GIS) application to provide citizens with information on places where they can take shelter during episodes of extreme heat.

By applying an intersectional climate justice perspective and mixed approaches, the specific needs of the most vulnerable populations (namely the young and the elderly) will be identified. This study reveals that social and climate vulnerabilities, such as energy poverty and inadequate housing, exacerbate climate risks for lower-income residents, and seeks to structure the network of shelters in areas close to these places, which can be accessible to those who are in the city every day or who visit the urban space.

The results highlight the need for climate shelters, structured at different levels of priority, which offer shelter during extreme weather events but also address underlying structural inequalities. Such shelters include the creation/identification of inclusive and culturally appropriate spaces, as well as the development of adaptive capacities for the most vulnerable populations. This integrated approach aims to promote more resilient and equitable cities in the face of growing challenges related to Urban Heat Stress (UHS).

Through the application of Geographic Information Systems (GIS) and technologies, this study provides a robust methodology for assessing risk, integrating multi-layered data, and deriving actionable insights for management of public spaces. This study can be replicated in other territorial areas, benefiting from the notes in this proposal, the application of which can be readapted.

2. LITERATURE REVIEW

The repercussions of the contemporary CC process are manifest in numerous regions worldwide, exerting substantial influence on diverse economic sectors (Carleton & Hsiang, 2016). The urban climate adaptation strategy underscores the multifaceted nature of the risks posed by extreme heat (Hussain et al., 2024; Lopes et al., 2023; Parihar & Birman, 2024). A recurring theme in the literature is the role of Urban Heat Island (UHI), which is exacerbated by factors such as surface albedo, lack of vegetation, and anthropogenic heat sources. Research has underscored the significance of green, blue, and gray infrastructures in mitigating these risks by reducing Land Surface Temperature (LST) and enhancing microclimatic conditions (Lemus-Canovas et al., 2020; Lopes et al., 2024; Lopes, Remoaldo, Ribeiro, & Martín-Vide, 2022; Lopes, Remoaldo, Ribeiro, & Martín-Vide, 2022; Lopes, Vidal, et al., 2025; Pinto et al., 2024). Green infrastructure, comprising elements such as urban parks and tree canopies, offers shading and evapotranspiration benefits, while blue infrastructure, including rivers and fountains, facilitates cooling through water evaporation. Infrastructures of a gray classification include facilities designed to provide maintenance during the hottest days, such as libraries or museums, with free access for those who need it. Pinto et al. (2024) Pinto et al. (2024) proposed a four-tiered system of protection for varying degrees of severity in urban areas, ranging from temporary infrastructure to more substantial precautionary measures.

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