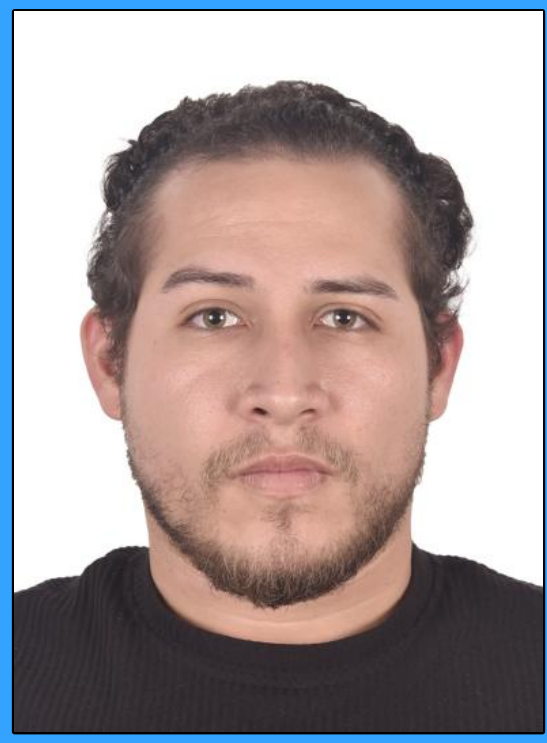




Multiscale Decision-Support Framework for Identifying and Retrofitting Climate Refuges in Spain under Future Urban Overheating

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ABSTRACT

Heatwaves and urban overheating are intensifying in European cities as climate change interacts with the urban heat island effect. Public buildings are increasingly designated as climate refuges, yet their selection and retrofit remain weakly connected to future climate projections, urban exposure patterns, and building thermal adequacy. This PhD develops a multiscale, predictive and reproducible framework to identify and retrofit public schools as climate refuges in Spain, with a first application in the city Barcelona. The framework links national climate-aware zoning, urban-scale prioritization, and building-scale validation to support climate-resilient adaptation decisions.

KEYWORDS

Heatwaves, urban overheating, climate refuges, public buildings, passive cooling strategies, geospatial framework, climate adaptation

PROBLEM

- Heatwaves and urban overheating are increasing in frequency and severity.
- Climate-refuge planning remains fragmented across climate, urban and building scales.
- Existing approaches are often accessibility-focused and rarely combine future exposure with building thermal adequacy.

OBJECTIVE / HYPOTHESIS

Objective — Develop a scenario-aware multiscale decision-support framework to improve the identification and climate-resilient retrofitting of public buildings as climate refuges in Spain.

H1 — Future warming changes bioclimatic zoning.

H2 — Urban heat exposure changes refuge-priority zones.

H3 — Passive and passive–hybrid retrofit packages improve overheating resilience under future heatwaves.

AUDIENCE

Municipal planners; school infrastructure managers; architects and engineers; climate-adaptation researchers; policy-makers.

RESEARCH QUESTION

RQ1 — Which passive and passive–hybrid retrofit strategies are most effective in reducing overheating across different climates and building typologies?

RQ2 — How will climate change alter the bioclimatic zoning of Spain, and how can these changes inform climate-specific passive and passive–hybrid retrofit strategies?

RQ3 — How can future overheating exposure, urban surface characteristics, and climate-refuge coverage gaps be integrated to identify and prioritize public buildings for climate-refuge planning in Barcelona?

RQ4 — To what extent can passive and passive–hybrid retrofit packages improve overheating resilience in a representative public school under present and future heatwave conditions?

ORIGINALITY

- Integrates country, city and building scales in one coherent pipeline.
- Connects where heat risk concentrates with which public assets should be prioritized and how they should be retrofitted.
- Uses public schools as a socially relevant demonstrator and produces a workflow transferable to other overheating-prone contexts.

METHODOLOGY

The thesis aims to shift climate-refuge planning from ad hoc designation to evidence-based, scenario-aware decision support. By connecting projected climate context, urban heat exposure and building-level thermal validation, the framework is designed to improve where to intervene, which public assets to prioritize and how to retrofit them.



EXPECTED RESULTS/ OUTPUTS

- Strategy Evidence Matrix for passive and passive–hybrid overheating mitigation strategies.
- Climate-change-aware bioclimatic zoning atlas for Spain and representative present/future climate files.
- High-resolution overheating-exposure, refuge-coverage and school-priority maps for the city of Barcelona.
- Calibrated public-school model and validated retrofit packages under present and future heatwave conditions.
- Transferable multiscale decision-support framework, journal manuscripts and thesis outputs.

CONCLUSIONS

The thesis aims to shift climate-refuge planning from ad hoc designation to evidence-based, scenario-aware decision support. By connecting projected climate context, urban heat exposure and building-level thermal validation, the framework is designed to improve where to intervene, which public assets to prioritize and how to retrofit them.

Resources

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