Politecnico di Torino

Honors Thesis

Master's degree Science in Architecture Construction City

Abstract

Decadal Land Surface Temperature and Land Cover Relationships in Turin: A Spatial Analysis Framework for Heat Risk Assessment and Architectural Intervention Strategies

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Testo abstract (4000 caratteri max) (Century Gothic 12, interlinea 16 pt). Usare lo stile "Testo Abstract".

This thesis establishes a spatial analytical framework that integrates decadal land surface temperature (LST) data from 2016 to 2025 with Copernicus Urban Atlas 2021 land cover data to examine urban heat patterns across the municipality of Turin, Italy. The city is highly exposed to surface heat stress, yet it lacks a systematic decadal satellite-based LST characterization that links physical surface conditions to socio-demographic vulnerability and to specific intervention strategies. This thesis aims to achieve four objectives: to analyze the decadal trends and seasonal patterns of LST; to identify which land cover characteristics most strongly influence the spatial variation of LST; to identify priority areas through a composite heat risk assessment; and to propose feasible architectural and urban intervention strategies for these areas.

Landsat 8 LST retrieval and temporal compositing are performed in Google Earth Engine (GEE). Annual and seasonal study-area trends are summarized using observation-count weighting (**Figure 1**), and the composites are aggregated to 3,472 cells on a regular 200 m grid in ArcGIS Pro. Land cover composition, tree canopy density, elevation, and a representative summer hillshade are joined to the same grid (**Figure 2**). A combined spatial autoregression model relates the decadal summer LST to these predictors, with winter LST retained for comparison. A composite heat risk score then integrates heat hazard, heat exposure, and heat vulnerability in a multiplicative framework. Heat vulnerability combines demographic sensitivity with road network access to green areas and drinking fountains. Priority Regions are identified from the resulting risk surface.

The results show that the annual mean LST is dominated by interannual variability rather than a monotonic trend. Summer is the critical heat season, with a study-area decadal mean LST of 39.4 °C and the greatest spatial thermal heterogeneity. The winter mean is 6.9 °C. Tree canopy density and water bodies are the strongest cooling controls, while dense built and sealed surfaces are the strongest warming influences. This land cover control is far stronger in summer than in winter. Only 4.2% of grid cells reach the high or very high heat risk classes. Six Priority Regions covering 4.60 km² combine high surface heat, dense population, and limited cooling capacity (**Figure 3**). Vegetation-based strategies, surface material strategies, and building envelope measures are matched to the diagnosed conditions, supported by built precedents in Turin and a regulatory pathway. Proposed measures include street trees, courtyard greening, cool roofs, and pavement retrofits. The assessment supports spatial screening and requires site-scale verification before implementation. The framework provides architects, urban planners, and policymakers with a reproducible, evidence-based tool for directing heat mitigation toward the areas of greatest need.

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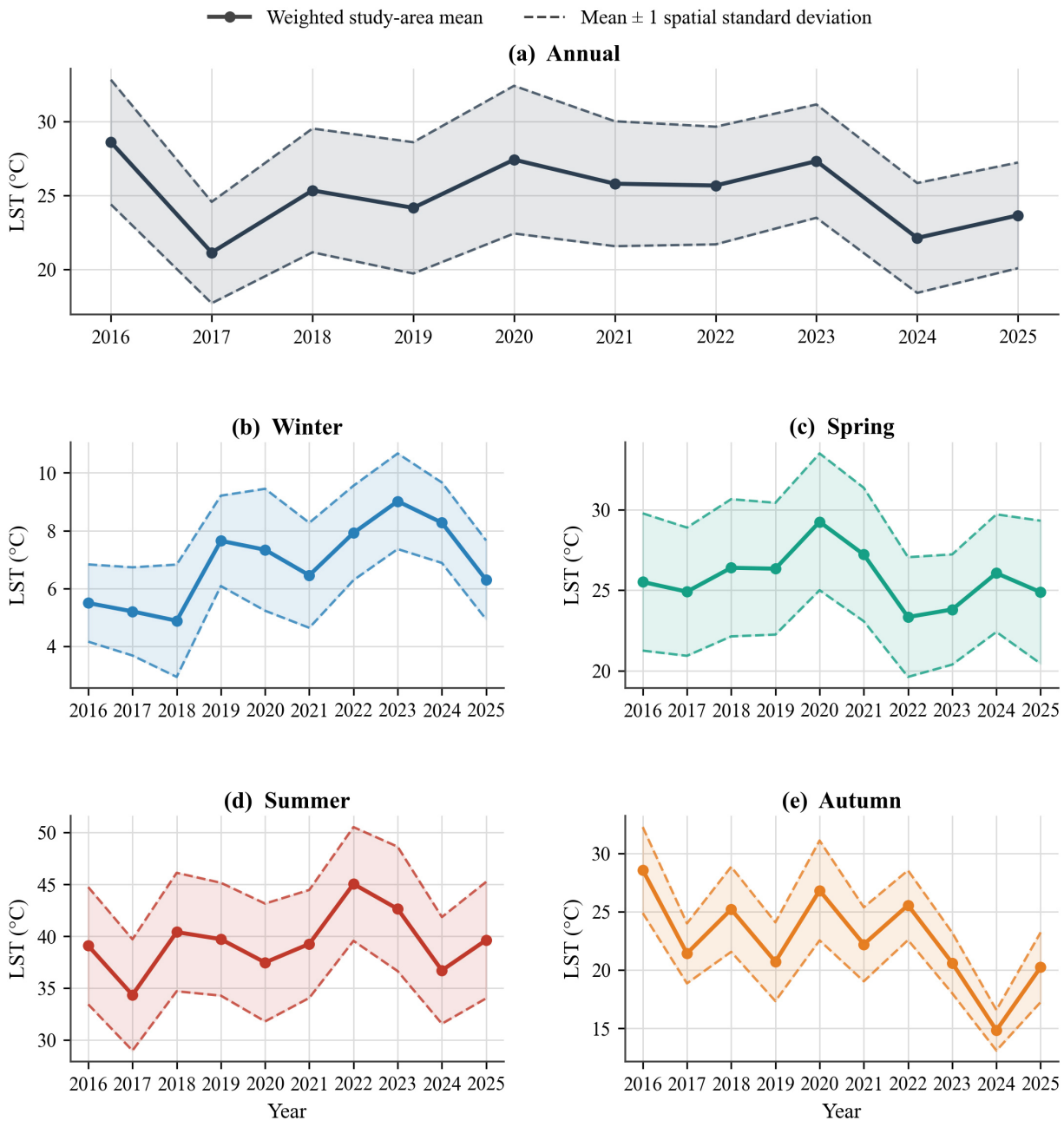


Figure 1. Annual and seasonal study-area weighted mean LST in Turin, 2016–2025: (a) annual; (b) winter; (c) spring; (d) summer; (e) autumn. Dashed lines mark the mean ±1 spatial standard deviation, showing intra-urban thermal heterogeneity. Source: thesis Figure 5.1.4.

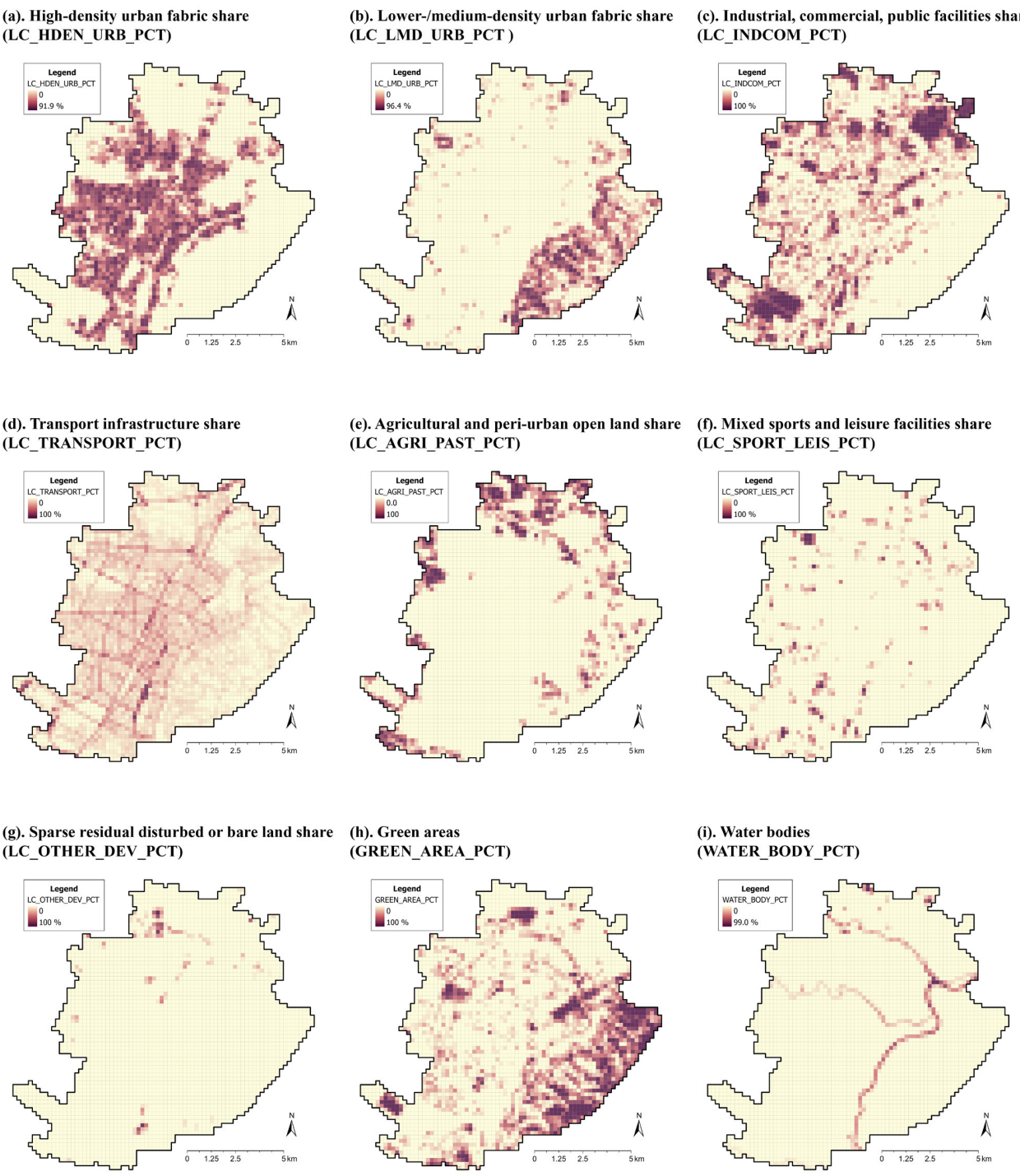


Figure 2. Land cover shares at 200 m, grouped from Copernicus Urban Atlas 2021. Source: thesis Figure 5.2.3.

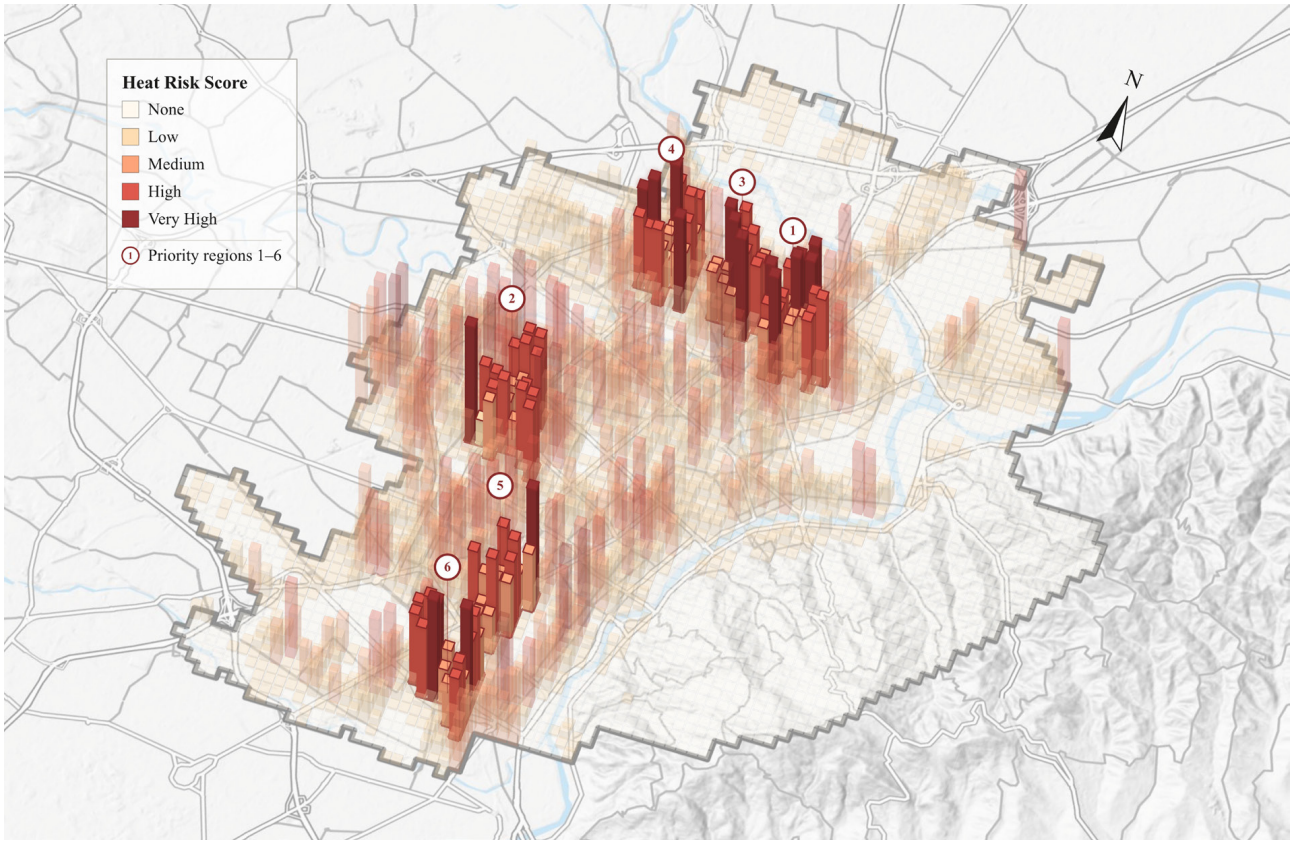


Figure 3. Six Priority Regions on the composite heat risk surface. Height shows heat risk score; color shows risk class. Source: thesis Figure 6.1.2. Basemap: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors.