URBAN HEAT RISK ASSESSMENT

EXPLORING A NOVEL PEDESTRIAN NETWORK-BASED FRAMEWORK

Massachusetts Institute of Technology
City Form Lab

POLITECNICO MILANO 1863

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MOTIVATION

- **Urban Heat Island Phenomenon**: The study stresses the need to evaluate heat risk, intensified by climate change and the urban heat island effect, especially for pedestrians
- **Pedestrian Heat Exposure**: The research highlights the significance of comprehending pedestrian heat exposure in cities using radiant temperature and pedestrian volume
- **Pedestrian Heat Vulnerability**: The study examines the susceptibility of pedestrians, especially vulnerable groups like children and the elderly, to heat
- **Sustainable Urban Planning**: The research emphasizes sustainable, equitable urban planning that considers heat risk and encourages non-auto transport
- **Heat-resilient cities**: The study seeks to guide planners and policymakers in developing heat-resilient, pedestrian-friendly cities through targeted, climate-adaptive planning

RESEARCH OBJECTIVES

- **Urban Heat Framework**: Create a framework bridging pedestrian mobility modeling and urban microclimate modeling to analyze heat exposure and risk along routes where people walk
- **Apply this framework to identify:**
  - o Street locations with high heat stress
  - o Residential locations where pedestrians at high risk of heat stress live

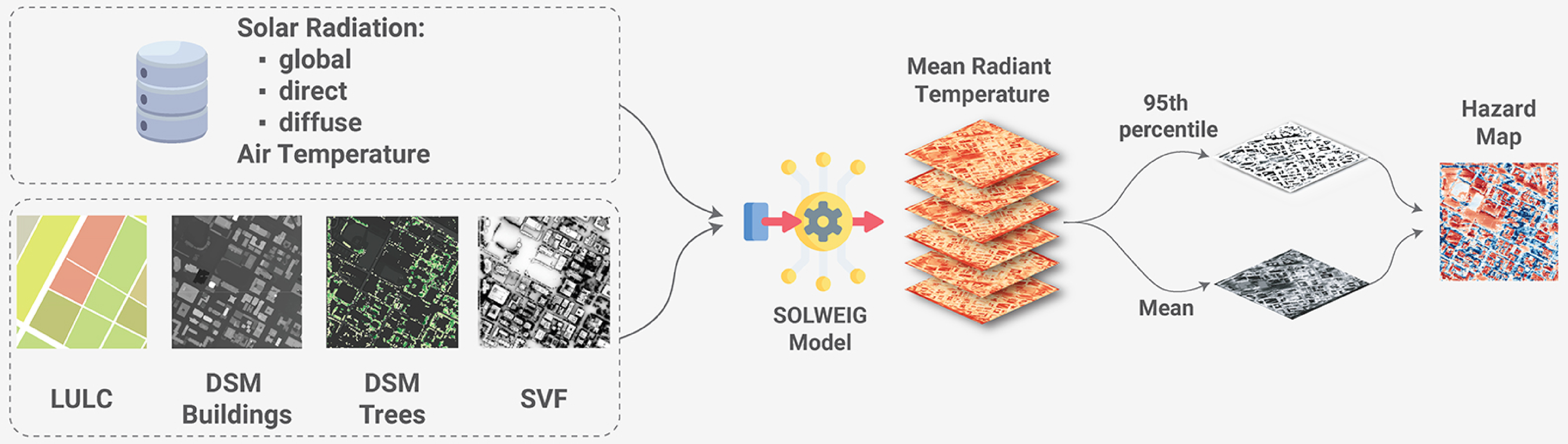
Study area: The urban heat risk assessment focuses on a 6km x 6km region around the Expo area in Los Angeles, California. This diverse area, with its mix of residential, commercial, and recreational spaces, is a key transportation hub. Recent subway expansion and the low-density environment, which leads to longer walks between transit stations, make it ideal for studying heat exposure and pedestrian comfort

PEDESTRIAN HEAT RISK ASSESSMENT FRAMEWORK

HEAT HAZARD: MEAN RADIANT TEMPERATURE

- Mean Radiant Temperature = *f*(Short and Longwave Solar Radiation, Air Temperature, Urban Geometry, Land Cover)
- Computed hourly at 1-meter spatial resolution using the SOLWEIG model
- Mean and 95th percentile values are calculated over daylight hours (8AM – 6PM) for each pixel during a heatwave event, from August 30th to the 9th of September 2022

- **Outcome**: Normalized heat hazard map (0-1 scale)



HEAT EXPOSURE: PEDESTRIAN VOLUME

The study employs a betweenness analysis to simulate pedestrian traffic considering different factors:

- Origins: Residential address points considered as homes
- Destinations: Bus stops, Subway stations, Parks, Amenities, Public schools
- Network: Sidewalk network created using the TILE2NET model applied on aerial imagery
- Trip Generation: Based on origin weights (number of people living at the origin)
- Trip Distribution: Based on several factors
  - o Destination weights and accessibility
  - o Street network attributes (connectivity)
  - o Behavioral nuances
    - Pedestrians willing to walk only up to a certain threshold
    - Consideration of routes other than the shortest route
    - Distance decay according to an exponential function
    - Probabilistic trip distribution across feasible route alternatives
- Obtained pedestrian volume estimates for each of the 5 trip types across the sidewalk network

Destination	Weight	Sufficiency Limit	Search Radius	β	Detour Ratio
Buses	Number of bus routes	Three distinct bus stops	800	0.001	15%
Subway	Number of Subway lines	One subway station	800	0.001	15%
Parks	Parkland area	Three Hectares parkland	800	0.001	15%
Amenities	Count	25 distinct business locations	800	0.001	15%
Public schools	School Capacity	three distinct schools	800	0.001	15%

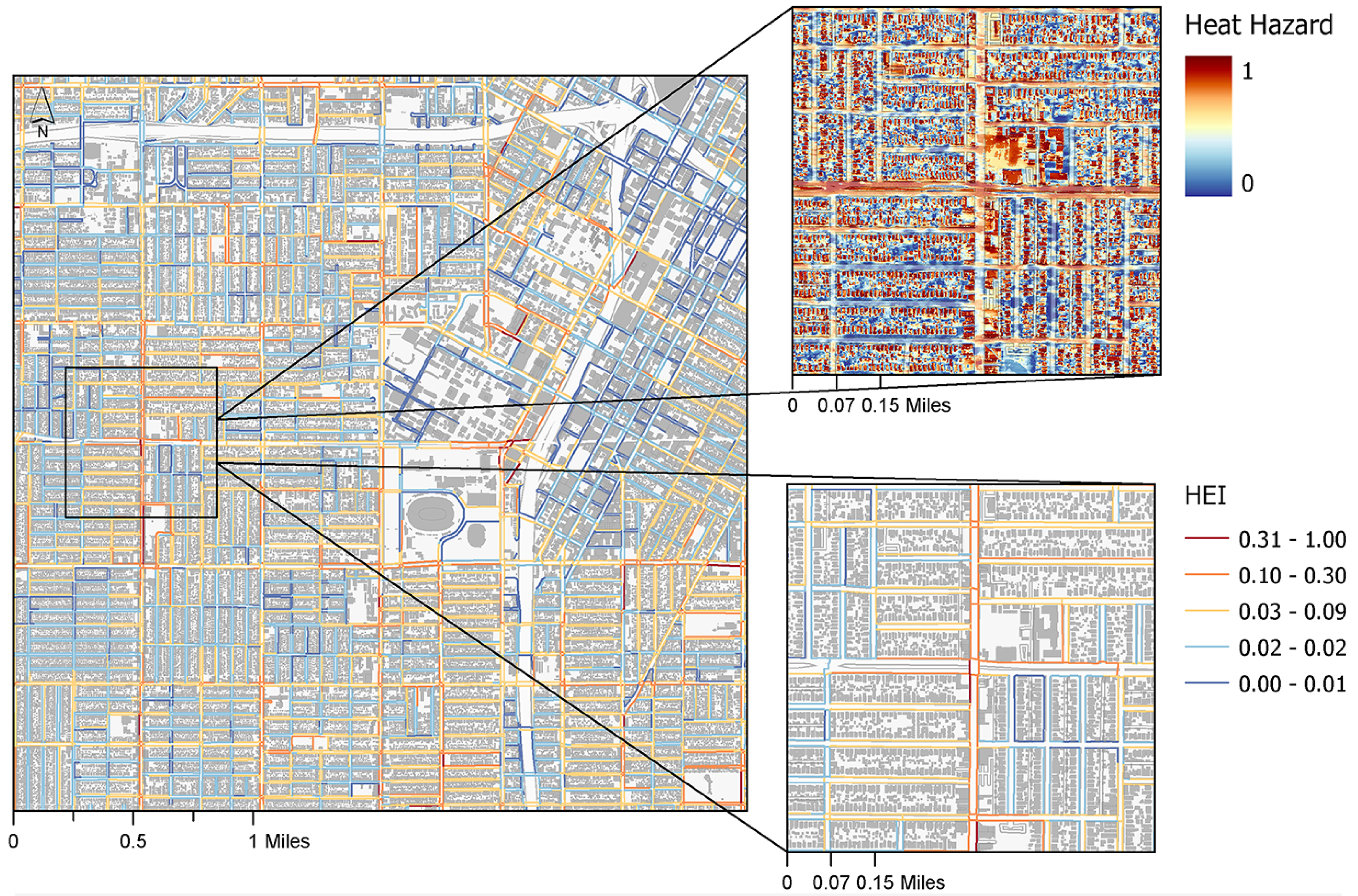
Limitation: Uncalibrated estimates due to lack of pedestrian count data
Outcome: Normalized total pedestrian volume for each sidewalk segment (0-1 scale)

HEAT VULNERABILITY: YOUNG CHILDREN & OLDER ADULTS

- More likely to be vulnerable to extreme heat effects
- Computed proportion of vulnerable population (< 5 yrs. and > 65 yrs.) at each home location

- **Outcome**: Normalized spatial distribution, at home locations, of heat vulnerability (0-1 scale)

RESULTS



Heat Exposure Index (HEI)
- HEI = Heat Hazard (Mean Radiant Temperature) * Heat Exposure (Pedestrian Volume)
- Calculated at the resolution of each segment in the sidewalk network (0-1 scale)
- **Use**: Identification of most heat-stressed sidewalks

Heat Risk
- Heat Risk = HEI * Heat Vulnerability (Young Children & Older Adults)
- Calculated at the resolution of each origin - home address point (0-1 scale)
- **Use**: Identification of where pedestrians with greatest heat risk live