Cross-City Insights into Urban Heat Hotspots: Evidence from Ouagadougou, Burkina Faso

Section	Summary
Prior Work	Climatematch project "Concrete Heat" (Shanghai) showed impervious surfaces (NDBI ↑) correlated with heatwave frequency. Identified the need to move from temporal correlation to spatial drivers.
Research Question	Which factors drive intra-urban heat hotspots in Ouagadougou? Are these drivers roughly comparable across very different urban–climatic contexts (Asia vs. Sahel)? How do the identified factors compare to the ones found by Hoang et al. (2025)? What are the most influential environmental and urban factors driving hotspot formation in Ouagadougou, Burkina Faso? What is the effectiveness of machine learning models in identifying hotspots during heatwave events?
Hypothesis	Hot spots are consistently linked to built-up density and vegetation loss, but local climate modifies their magnitude.
Objectives	(1) Replicate & adapt Hoang et al. (2025) workflow for Ouagadougou. (2) Identify and rank drivers of urban heat. (3) Compare Ouagadougou, Da Nang, and Shanghai. (4) Test a policy scenario (green space addition).
Expected Outcomes	- Clean geospatial dataset + interpretable ML model. - Heat vulnerability maps for Ouagadougou. - Cross-city comparative insights. - Stakeholder-relevant outputs: planning scenarios & seminar dissemination.

Table 1: Prior Work, Research Question, Hypothesis, Objectives & Outcomes

Methodology

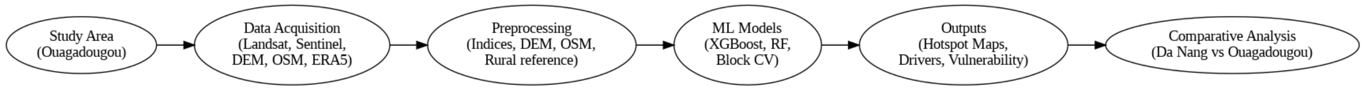
Heatwave days are identified using ETCCDI indices (TX90p, WSDI) from ERA5-Land, with events defined as ≥6 consecutive days above the 90th percentile. Cloud-free Landsat-8/Sentinel-2 composites are processed to extract LST and indices (NDVI, NDBI, MNDWI), along with contextual data (DEM, OSM, GHSL). Heatwave intensity is expressed as LST anomalies against rural reference areas, with both continuous and binary hotspot targets. Models (XGBoost, Random Forest) are trained with stratified sampling and spatial block CV, and evaluated using Accuracy, F1, Kappa, R^2, and MAE. SHAP analysis provides interpretable driver rankings, and results are compared across Ouagadougou, Da Nang, and Shanghai. Unlike earlier work (Shanghai = temporal focus; Da Nang = coastal Asia), this study brings first evidence from a Sahelian capital, enabling transferability testing across continents. To our knowledge, this will be the first systematic UHI driver study in West Africa, addressing a major geographical blind spot in the literature. The process is depicted in Figure 2

Table 2: Data Sources

Data	Source	Use
Landsat-8, Sentinel-2	NASA/ESA	LST, NDVI, NDBI, MNDWI
MODIS		LST (alternative, simpler to use and high quality)
DEM (Copernicus)	ESA	Elevation, slope
OpenStreetMap	OSM	Roads, water networks
GHSL	EC JRC	Population, built-up density

ERA5-Land	ECMWF	Baseline climatology (LST alternative?)

Figure 1: Workflow



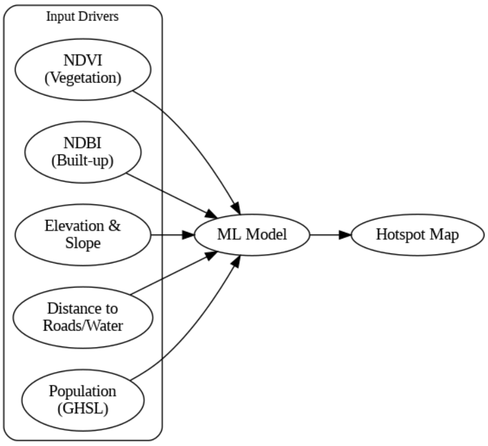


Figure 2: To translate Earth Observation and socio-environmental datasets into actionable outputs, we model the relationship between key drivers and heatwave hotspots. Predictors include NDVI (vegetation), NDBI (built-up density), elevation & slope, distance to roads/water, and population density (GHSL). These variables are processed through machine learning models (XGBoost and Random Forest), which are trained to classify hotspot and non-hotspot pixels. The final output is a spatially explicit heat vulnerability map of Ouagadougou that highlights urban areas most at risk.

Approach

- Heatwave events defined via ETCCDI indices (TX90p, WSDI).
- Anomalies computed vs. rural reference areas.
- Predictors: NDVI, NDBI, MNDWI, slope/elevation, green density, built-up share, distance to roads/water, population.
- Models: XGBoost + RF (stratified cross-validation, SHAP interpretability).
- Deliverables: hotspot maps + driver rankings for Ouagadougou; direct comparison with Da Nang & Shanghai.

Expected Outputs & Impact

Scientific: First comparative UHI transferability study (Asia–Africa).

Practical tools: Vulnerability maps & scenario tests for planners.

Capacity building: Micropublication + seminar to disseminate results.

Outputs will be shared with urban resilience actors (Ouagadougou City Council, UN-Habitat Sahel projects), ensuring alignment with real adaptation needs.”

Timeline & Feasibility

Strength: Prior Shanghai pipeline ensures technical feasibility; methods already tested. We have already built and tested a preprocessing pipeline for Landsat imagery (Shanghai case), ensuring feasibility for Ouagadougou.

Risk Mitigation: Sentinel imagery backs Landsat if cloud cover persists. Simpler models ensure feasibility within 6 months. If data gaps persist, ERA5 reanalysis will provide fallback climatology for hotspot detection.

Timeline (Table 3: Gantt Chart): Data prep → Heatwave extraction → ML → Comparison → Outputs → Dissemination.

Task	Oct	Nov	Dec	Jan	Feb	Mar
Data Collection & Preprocessing						
Heatwave Event Extraction						
ML Model Training & Validation						

Table 3: Gantt Chart

Comparative Analysis (Da Nang vs Ouagadougou)				■	■	
Output Generation (Maps, Reports)					■	
Final Seminar + Micropublication						■