Urban Heat Vulnerability Analysis: Conceptual Framework

VULNERABILITY COMPONENTS

EXPOSURE

- Urban Heat Islands
- Land Surface Temperature
- Vegetation Index
- Impervious Surface
- Building Density

SENSITIVITY

- Age Demographics
- Pre-existing Health Conditions
- Comorbidities
- Physiological Factors
- Health Inequalities

ADAPTIVE CAPACITY

- Air Conditioning Access
- Housing Quality
- Healthcare Access
- Green Space Proximity
- Income Levels

ANALYTICAL LENSES

INFRASTRUCTURAL JUSTICE

- Unequal access to protective infrastructure
- Spatial disparities in urban development

CLIMATE RESILIENCE

- Adaptive capacity building
- Climate-ready urban planning

HEALTH EQUITY

- Differential health outcomes
- Identifying vulnerable populations

RESEARCH PHASES

1. VULNERABILITY MAPPING

Spatial analysis of heat vulnerability patterns across Johannesburg

2. CAUSAL ANALYSIS

Identifying mechanisms driving heat-health outcomes through causal inference

3. PREDICTIVE MODELING

Forecasting heat-health risks and identifying critical thresholds

KEY METHODOLOGICAL APPROACHES

- Geographically Weighted Principal Component Analysis (GW-PCA)
- Causal Machine Learning (PC Algorithm, Double Machine Learning)
- Spatio-temporal Distributed Lag Non-linear Models (DLNM)
- Ensemble Prediction with Uncertainty Quantification

Note: This research focuses on understanding vulnerability patterns, causal mechanisms, and predictive capabilities. The development and implementation of interventions falls outside the scope of this PhD.