URBAN HEAT ISLANDS IN OLOMOUC:

A Geospatial Identification of Thermal Patterns, Urban Structure, and Human Perception

Diploma Thesis

Motivation & Objectives

Extreme heat is one of the fastest growing **climate risks** for cities and Europe is warming faster than any other continent. Yet most **urban heat island (UHI)** research relies on physical measurements alone and overlooks how people actually experience heat. This thesis therefore develops a **geospatial framework for Olomouc** that combines satellite and sensor-based thermal data with participatory mapping and socio-demographic data, following the **IPCC's climate risk framework**.

The following objectives guide this thesis:

- **Harmonizing** thermal, urban structure and socio-demographic data within a common spatial framework.
- **Developing** and implementing a transferable UHI risk model.
- **Communicating** the results through an interactive web mapping application.

Methods & Workflow

All indicator data was first harmonized within a **100 m hexagonal grid**, allowing consistent comparison across the city despite the varying spatial resolutions of the input datasets. Each indicator was then **normalized** to a 0–1 scale. These normalized indicators were combined using the UHI risk model, from which the final risk score was computed and visualized.

To assess how well the model reflects real thermal conditions, the hazard component was **validated** against an independent network of ten weather stations. Finally, the results were compiled into an **interactive web mapping application**, allowing decision-makers to explore risk patterns and identify priority areas for UHI mitigation.

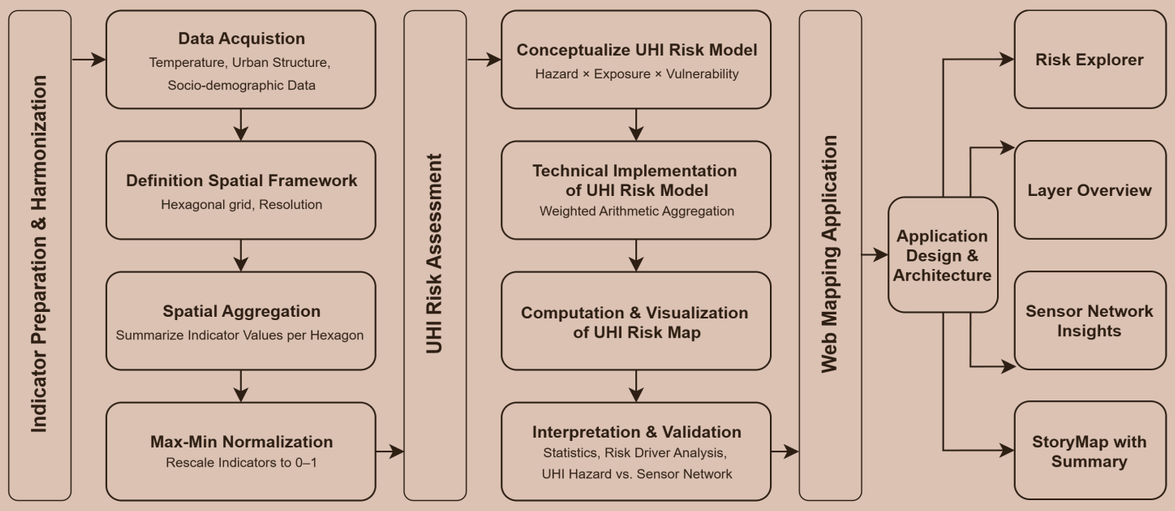

Figure 1 Workflow of this study.

UHI Risk Model

The model was implemented as an open, **transferable ArcGIS Pro toolbox** that can be applied to other cities and datasets. It combines the four components hazard, exposure, sensitivity and adaptive capacity using **weighted arithmetic aggregation** into a final risk score for each hexagon.

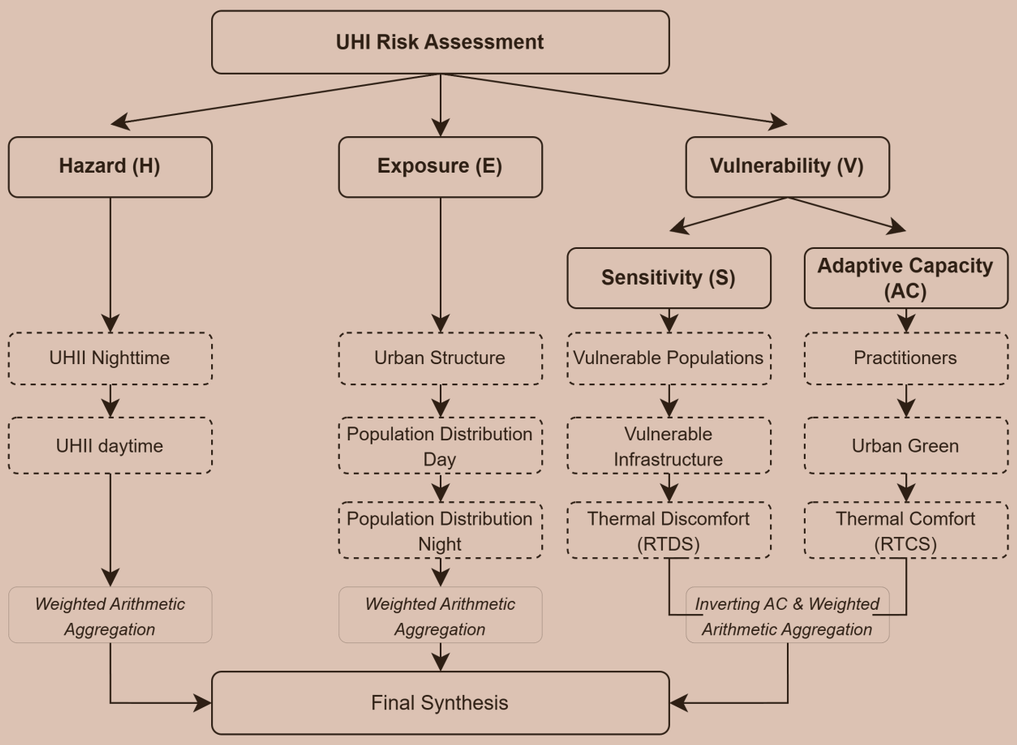

Figure 2 Calculation of UHI risk based on hazard, exposure and vulnerability.

Hazard

Physical intensity of surface heating (land surface temperature)

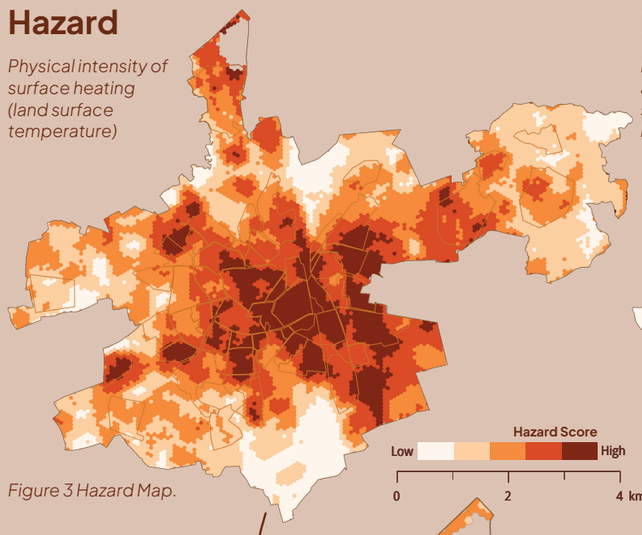

Figure 3 Hazard Map.

Exposure

Presence of people and built-up structures subject to heat

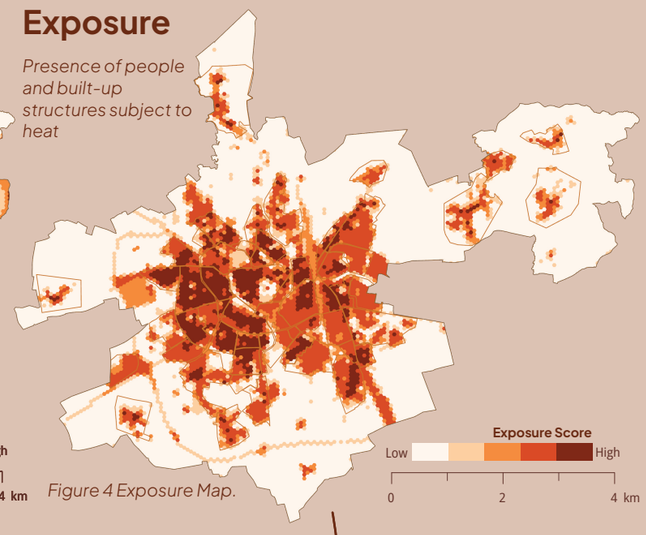

Figure 4 Exposure Map.

UHI Risk

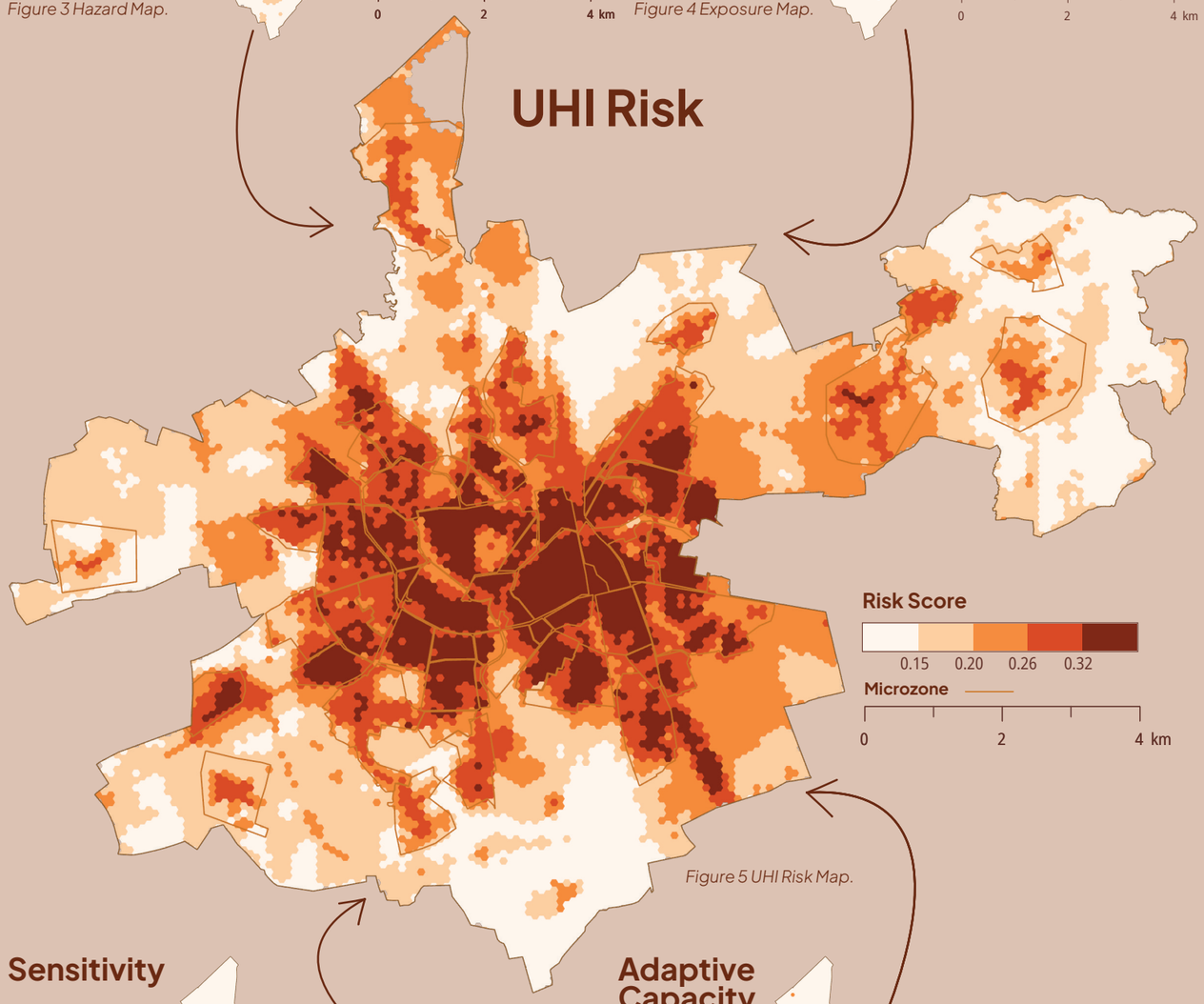

Figure 5 UHI Risk Map.

Sensitivity

Susceptibility of the population to heat-related harm

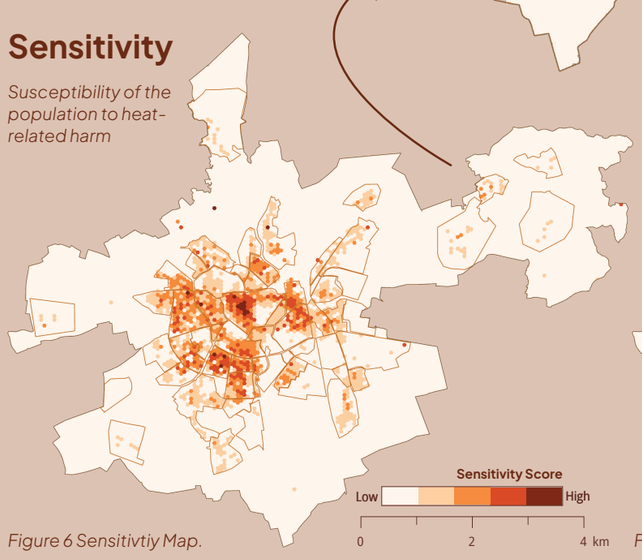

Figure 6 Sensitivtiy Map.

Adaptive Capacity

Ability of a city to cope with and recover from heat

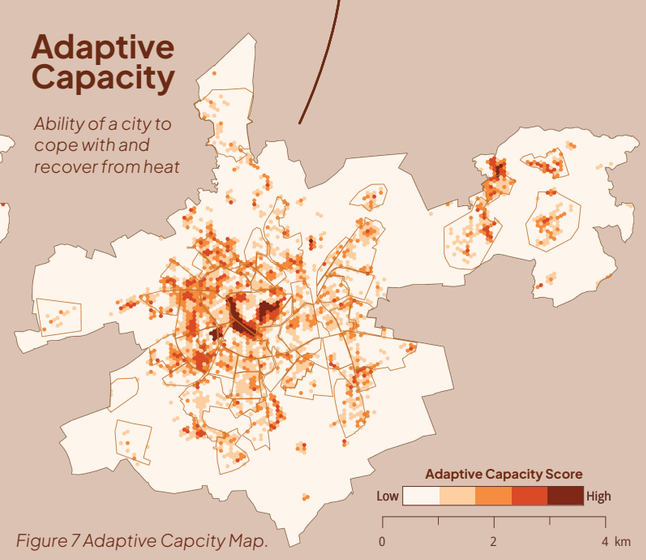

Figure 7 Adaptive Capcity Map.

Results

UHI risk is highest in and around Olomouc's densely built city center, but its underlying drivers vary considerably across the city. **Industrial** and **commercial zones** are shaped mainly by high hazard from sealed surfaces, while **residential neighborhoods** like Nové Sady and Povel stand out due to a high concentration of vulnerable residents rather than heat intensity alone. Public parks consistently lower risk, reducing both surface temperature and improving reported thermal comfort.

These patterns translate into distinct **priority zones** with tailored recommendations: **shading and cooling measures** for the pedestrian-heavy city center, **early warning systems** for vulnerable residential areas, and **heat-load reduction** in industrial zones to limit their impact on neighboring residents.

Validating the hazard component against the ten sensor stations revealed only weak agreement with nighttime air temperature patterns, showing that satellite-derived surface temperature alone does not fully capture how heat is experienced at ground level. A comparison with Olomouc's existing adaptation strategy further confirmed that this thesis captures socio-demographic vulnerability that purely physical susceptibility maps tend to overlook, underlining the value of a human-centered perspective on UHI risk.

Contribution of the Work

This thesis shows that UHI risk cannot be understood through physical measurements alone, but that it emerges where heat, urban structure and human vulnerability intersect. By combining these dimensions in a single, reproducible framework, the results move beyond static maps into a **practical planning tool** that decision-makers can use. As cities across Central Europe face increasingly frequent heatwaves, this transferable, open and **human-centered** model can become an essential foundation for building **climate-resilient and livable urban futures**.

Scan for further insights, high-resolution maps and the web mapping application.

COPERNICUS MASTER IN DIGITAL EARTH
PARIS LODRON UNIVERSITÄT SALZBURG
Palacký University Olomouc

Supervisor: Dr. Jakub Koníček, Department of Geoinformatics, Faculty of Science, Palacký University Olomouc
Co-Supervisor: Dr. Christoph Traun, Department of Geoinformatics, Paris Lodron University Salzburg
Attachment to diploma thesis no. 1