PREDICTIVE MODELLING OF URBAN HEAT ISLAND EFFECT USING MACHINE LEARNING TECHNIQUES

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Introduction

In recent years, urban areas globally have become home to unprecedented numbers of the human population. As of 2024, over 4 billion people, accounting for more than half of the global population, reside in urban areas. This urbanisation has led to the rapid development and expansion of cities. An observable consequence of this urbanisation is the urban heat island (UHI) effect, where cities experience higher temperatures than their surrounding rural areas. It is important to note that the intensity of the UHI effect varies across different cities around the world, influenced by diverse urban, environmental, and climate conditions. This research aims to develop a comprehensive predictive model integrating various factors influencing the UHI intensity across different urban environments using machine learning techniques.

Data

The scope of this research encompasses more than 200 global cities, each with a population exceeding 2.5 million, ensuring a comprehensive coverage across diverse geographic, climatic, and urban contexts, spanning both the global north and global south.

Land Use Data: Sentinel-2 Satellite Imagery
Sentinel-2 satellite imagery will be used to extract information of vegetation cover, waterbody cover, and built-up area cover in CBDs.

Meteorological Data: NASA POWER Project
The NASA POWER Project provides a comprehensive global dataset, including temperature, humidity, wind speed, wind direction, precipitation data, etc. Data collection is focused on the summer months (June, July, and August for the Northern Hemisphere; November, December, and January for the Southern Hemisphere) to capture the periods when the UHI effect intensifies temperature extremes. This study's data span a five-year period from 2019 to 2023.

Population Data: Census Data
The population data will be sourced from the national census data published by each country. Rather than focusing on the population within CBDs, the total population of the broader metropolitan areas will be considered.

Methodology

Step 1: Site Selection

Step 2: Data Acquisition and Data Pre-processing

Step 3: Data Integration

Step 4: Model Training

Step 5: Model Evaluation and Hypothesis Testing

Step 6: Building Dashboard

Professional Tools

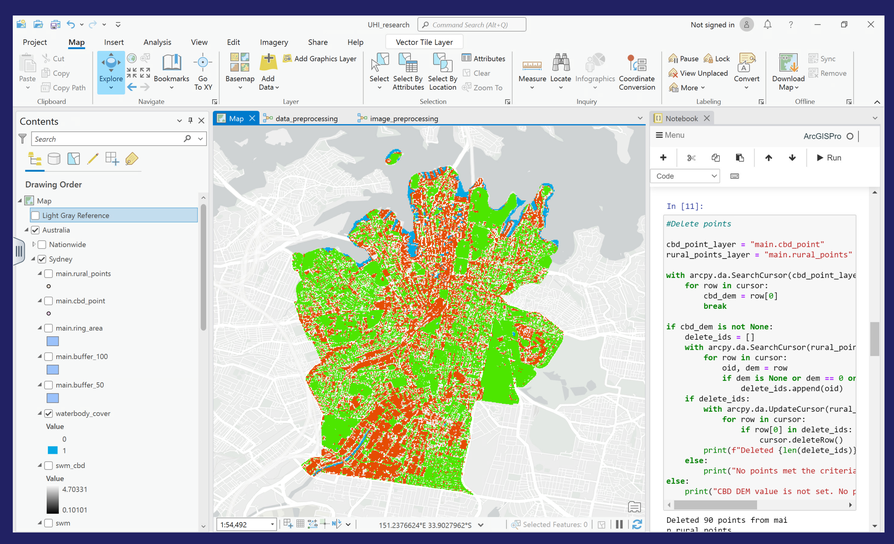
ArcGIS Pro
ArcGIS Pro is employed to perform spatial analysis, which involving selecting comparable sites in both urban and rural settings and extracting information from satellite imagery across over 200 cities worldwide.

Python
Python enhances geospatial processing in ArcGIS Pro through ArcPy, and supports model training and evaluation with machine learning libraries such as scikit-learn.

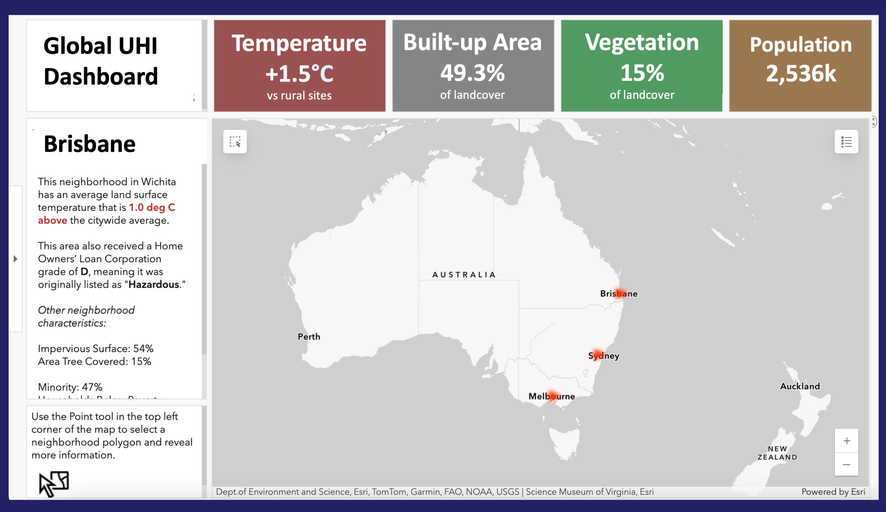
ArcGIS Dashboards
ArcGIS Dashboards is used to display acquired data and analysis results, alongside predictions versus actual observations. It also includes a detailed guide on the research methodology and data sources.

Expected Outcomes

A model designed to predict the intensity of the UHI effect in urban areas will be developed. This model will be built by leveraging acquired data and the outcomes of spatial analysis conducted in ArcGIS Pro.



Also, a comprehensive dashboard will be established. This dashboard will not only enable a city-specific analysis but also allow users to view the broader patterns of UHI distribution globally. It will feature interactive maps showcasing CBDs and surrounding rural areas and diverse charts for visualising key factors like vegetation and built-up areas.



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Research Proposal