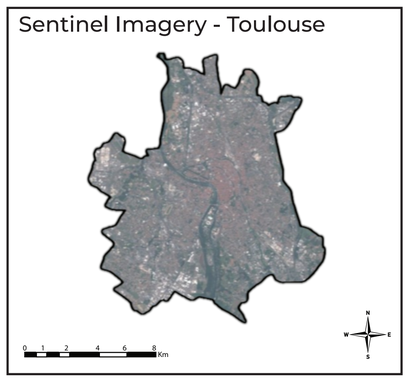
Assessing Heat Vulnerability in Toulouse: A Spatiotemporal Approach Using Google Earth Engine

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Capgemini

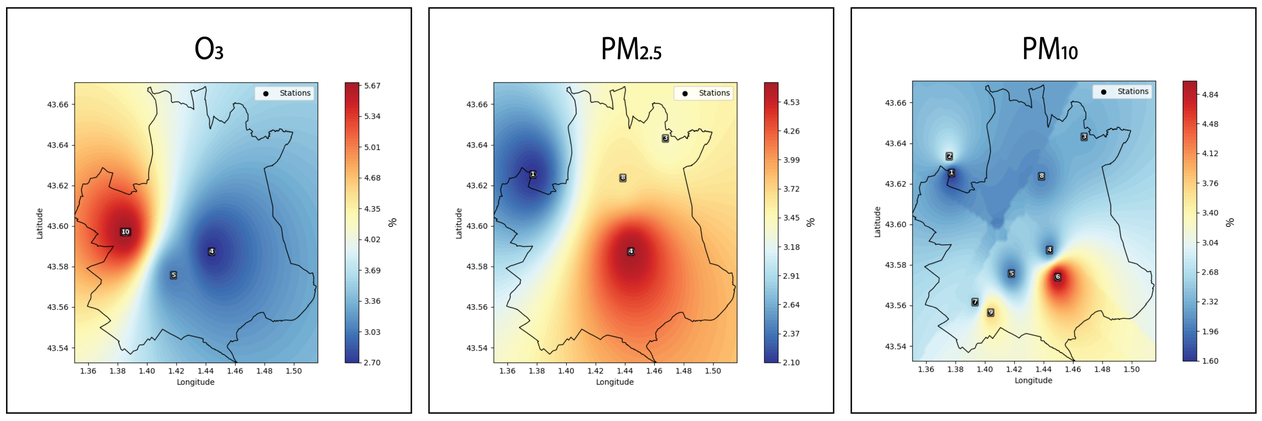
Introduction

- Cloud cover: <10%
- Total area: 118.3 km²
- Population density: 4,325/km²
- Elderly population: 14.5%
- Socially isolated elders: 6%
- Literacy rate: 4%
- Poverty rate: 22%



Urbanization, anthropogenic heat and climate change represent an increasing public health concern. This study introduces a spatial Heat Vulnerability Index (HVI), developed by integrating multiple environmental and socio-economic risk factors to systematically identify and assess areas most vulnerable to heat waves and poor air quality.

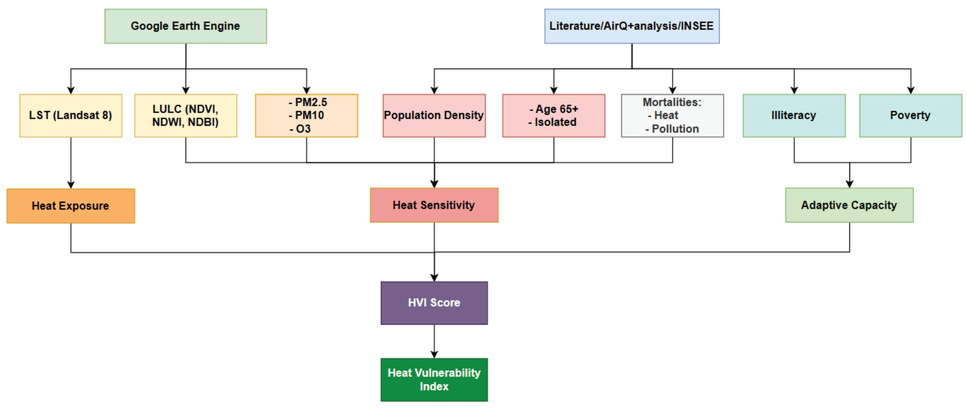
Risk Interpolation - August 2023



Station - Location

1. Blagnac airport piste - Observation peri-urban
2. Blagnac airport traffic side
3. Toulouse- Route albi traffic side
4. Toulouse-Berthelot urban
5. Toulouse-Jacquier urban
6. Toulouse-Périphérique observation
7. Toulouse-SETMI eisenhower industrial
8. Toulouse-Mazades urban
9. Toulouse-SETMI chapitre industrial
10. Station pédagogique

Methodology

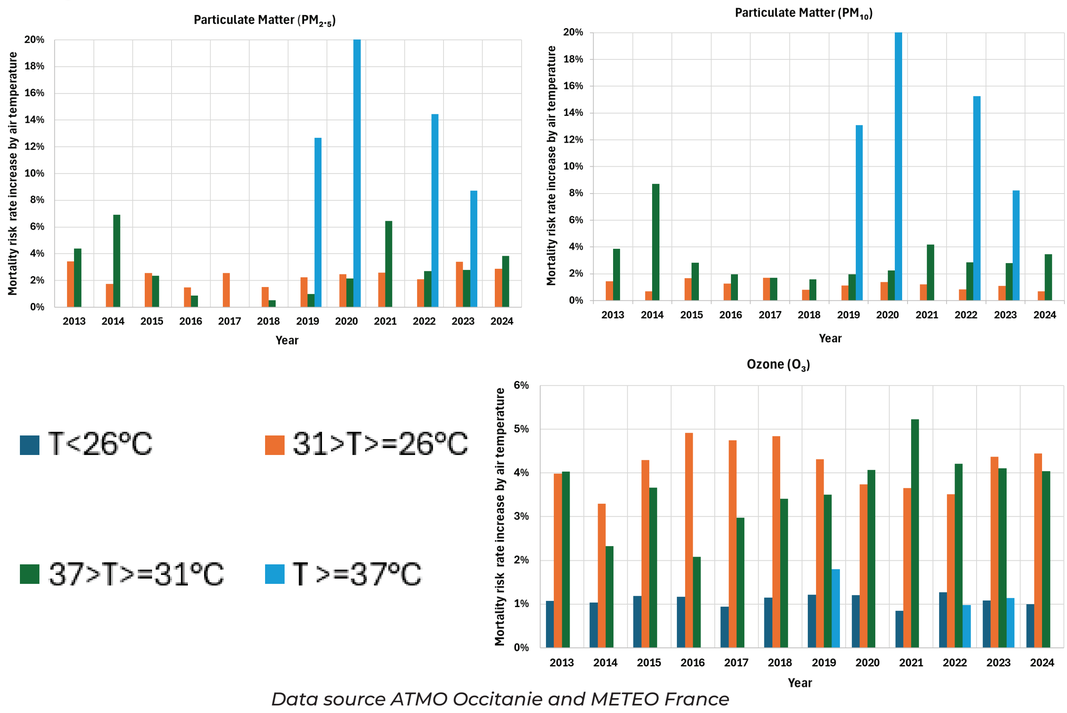


Objectives:

- Integrates geospatial environmental data, socioeconomic indicators, and mortality risk rate to derive HVI.
- Apply a data-driven approach to produce interactive, time-sensitive vulnerability maps.
- Identify neighborhoods most vulnerable to extreme events (heat and air pollution).

Data analysis

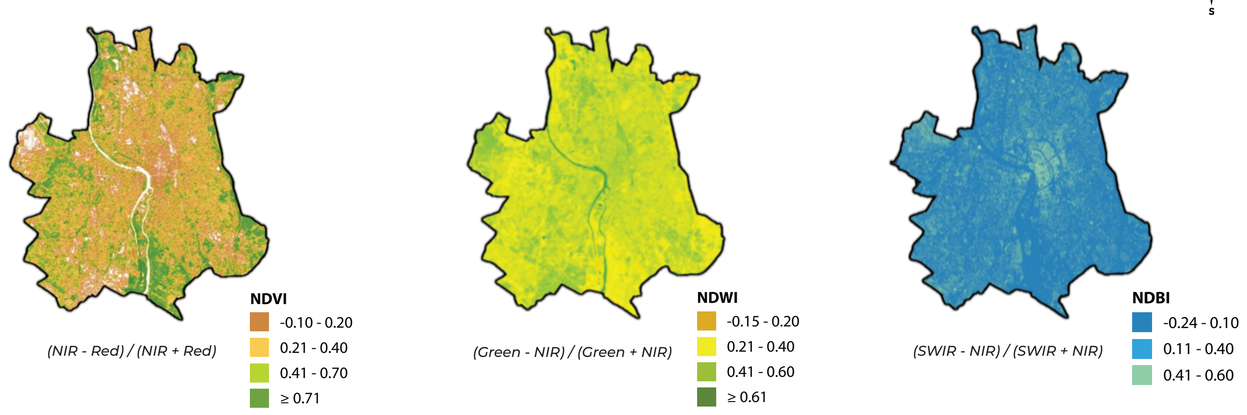
The variability in mortality risk due to air pollutant concentrations under different temperature conditions was assessed using the AirQ+ model.

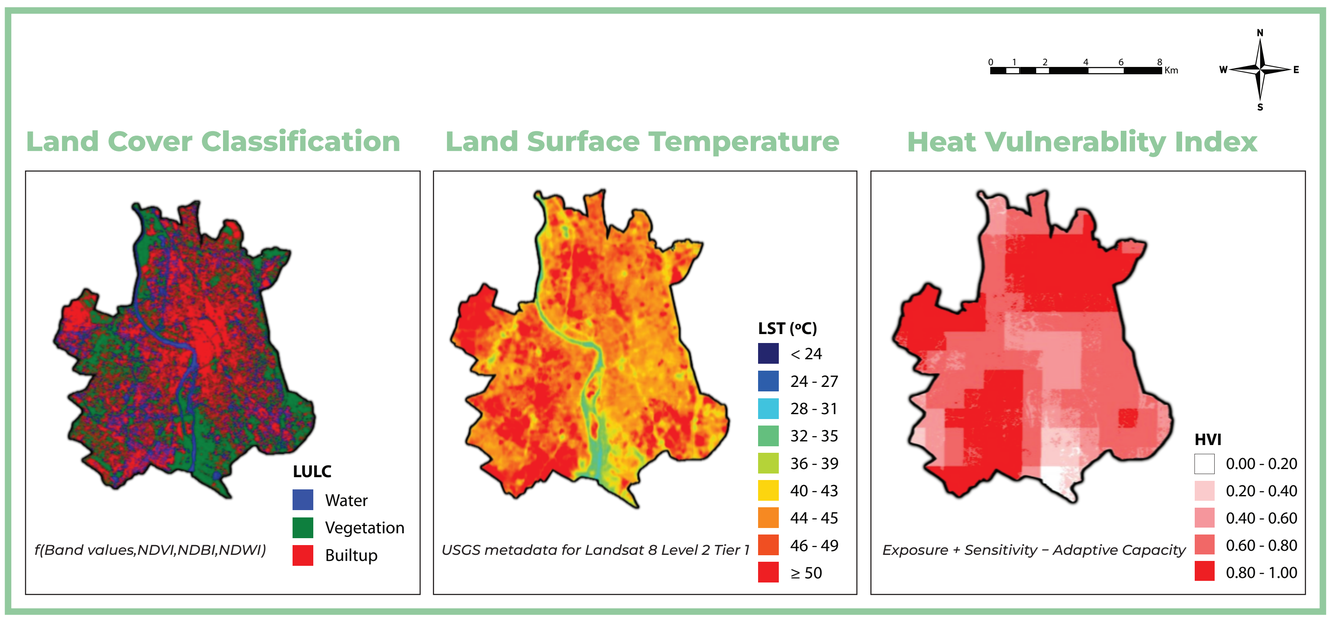


Data source ATMO Occitanie and METEO France

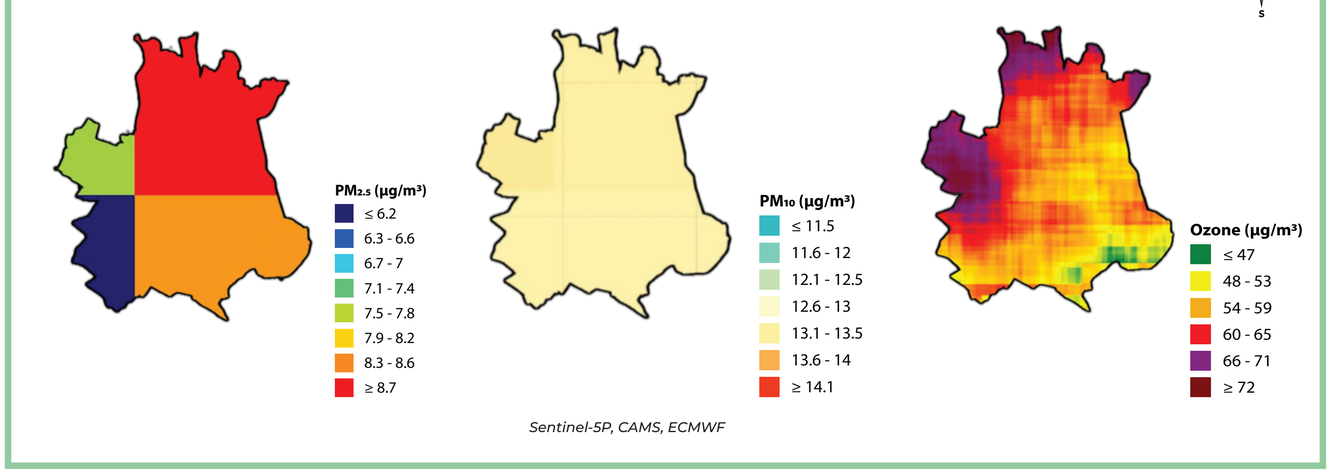
Results & Discussion

Spectral Indices





Air Quality



Sentinel-5P, CAMS, ECMWF

Main Findings

- A strong correlation found between urban heat and air pollution, with their combined effects significantly increasing health risks particularly in densely populated urban areas.
- Consistent rise in heat vulnerability observed, especially in zones with low vegetation cover and high concentrations of heat-absorbing surfaces such as concrete and asphalt.
- The resultant maps identifies priority areas for mitigation to improve public health and urban resilience. It supports decision makers for planning strategies focused on greener, heat resilient urban environment.



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References:

- Qureshi, A. M., & Rachid, A. (2022). Heat vulnerability index mapping: a case study of a medium-sized city (Amiens). Climate, 10(8), 113.
- Li, H., Meier, F., Lee, X., Chakraborty, T., Liu, J., Schaap, M., & Sodoudi, S. (2018). Interaction between urban heat island and urban pollution island during summer in Berlin. Science of the total environment, 636, 818-828.