Quantification and evaluation of the heat-stress hazard variability in Tuscany between 2003 and 2022

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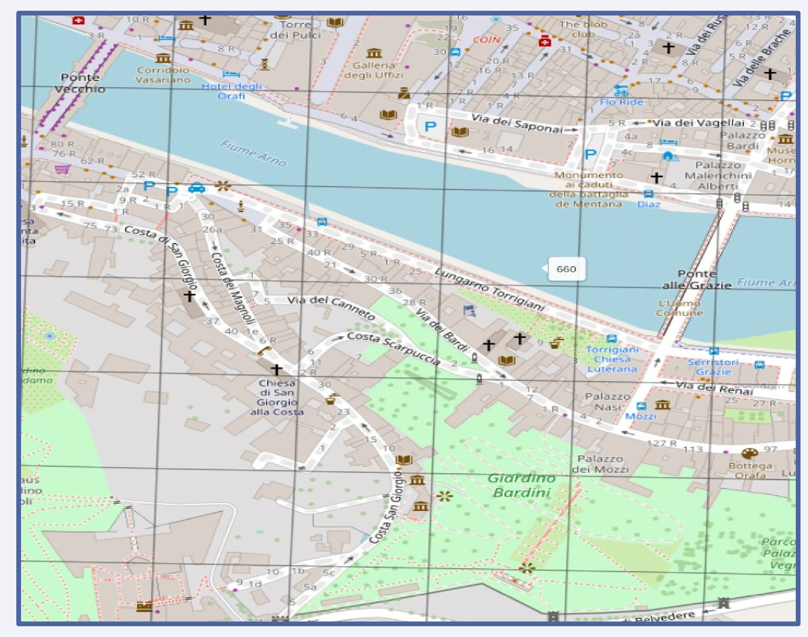
Background and Objective

- The **index of vulnerability** to extreme temperatures depends on both temperature and social factors.
- Urban areas, due to **heat island effect**, heighten susceptibility to high temperatures.
- This study aims to estimate fine scale temperature levels as the hazard component of the vulnerability index

Case study:

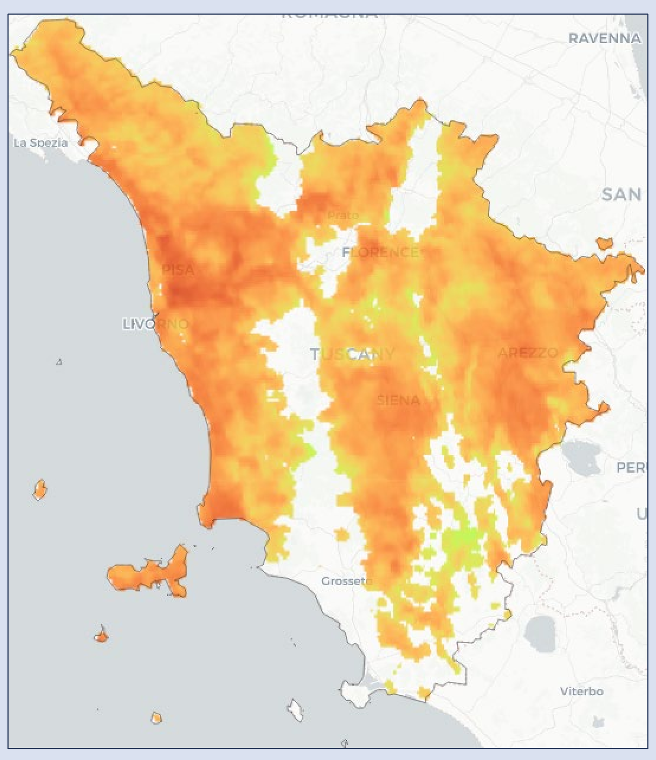
- Region: Tuscany
- Time period: 2003-2022
- Temporal resolution: 1 day
- Spatial resolution: **100m**



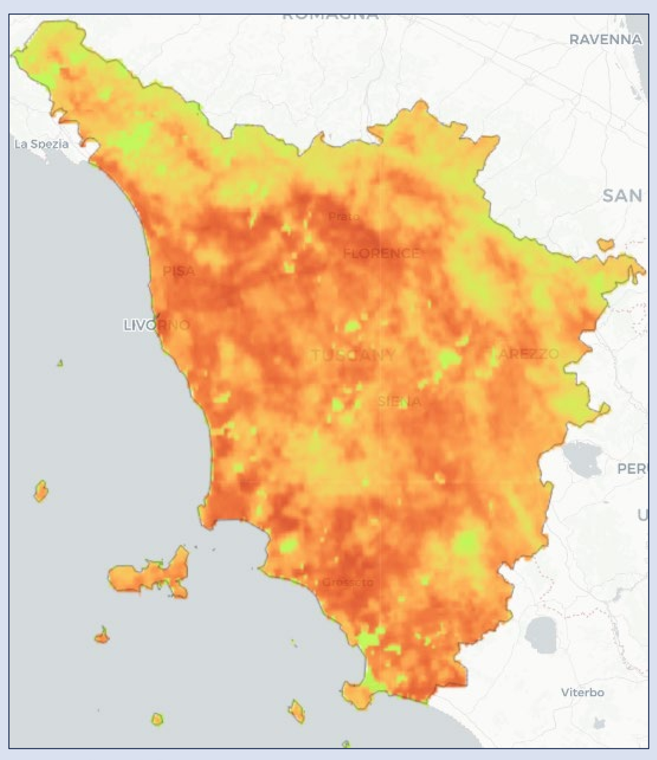
100m grid in Florence city center

Methods

Stage 1



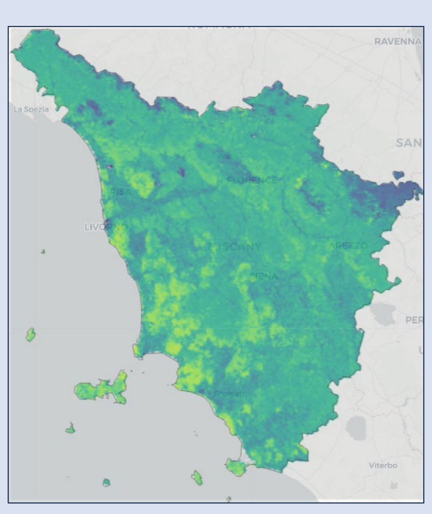
MODIS, with missing data



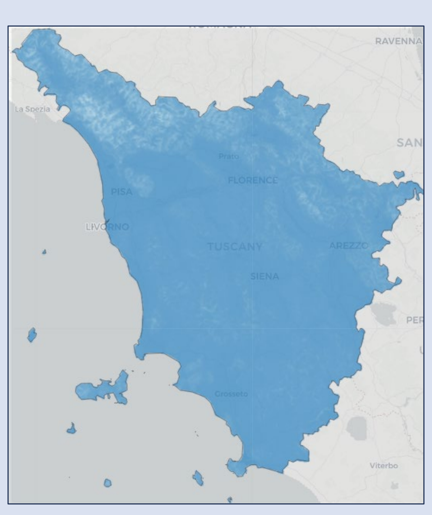
MODIS, with no missing data

Gradient Boosting using 10 predictors to impute missing satellite (MODIS) data:

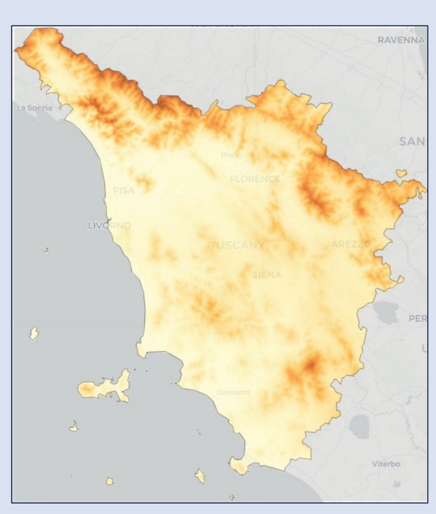
- Topography: Altitude (DEM), slope, aspect
- Sky View Factor (SVF)
- Normalized Difference Vegetation Index (NDVI)
- Solar Geometry (Azimuth, position, length of the day)
- Solar Radiation (direct/diffuse)



NDVI



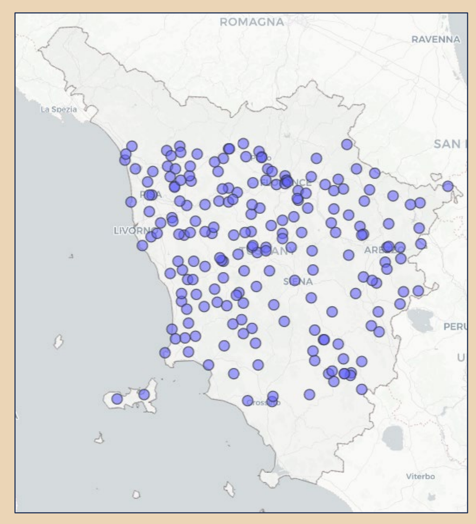
SVF



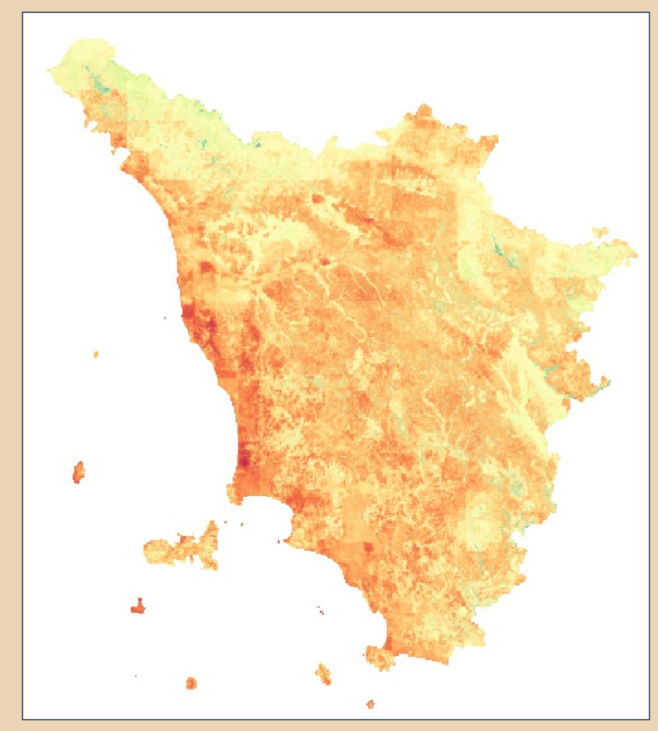
Elevation

Stage 2

Gradient Boosting to estimate tmin and tmax temperature

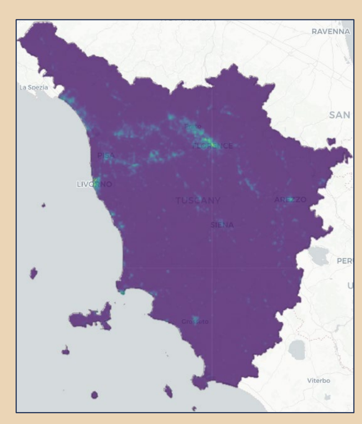


201 Ground Monitor

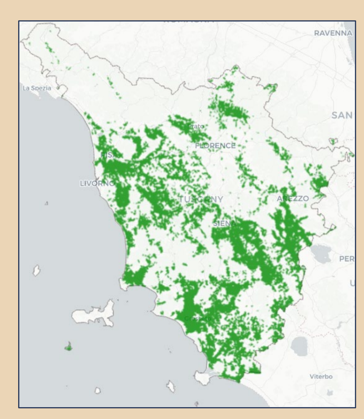


Temperature estimated, 100m resolution

19 spatial predictors



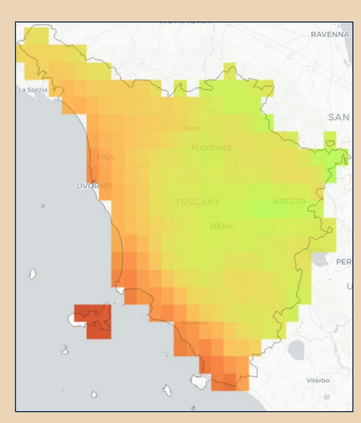
Nighttime light



Land Cover

Roads

16 temporal predictors



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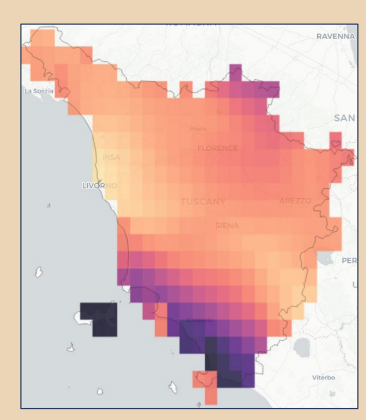
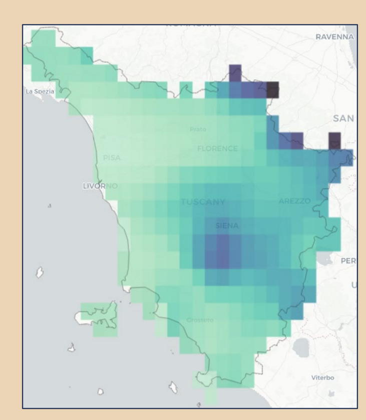


Wind



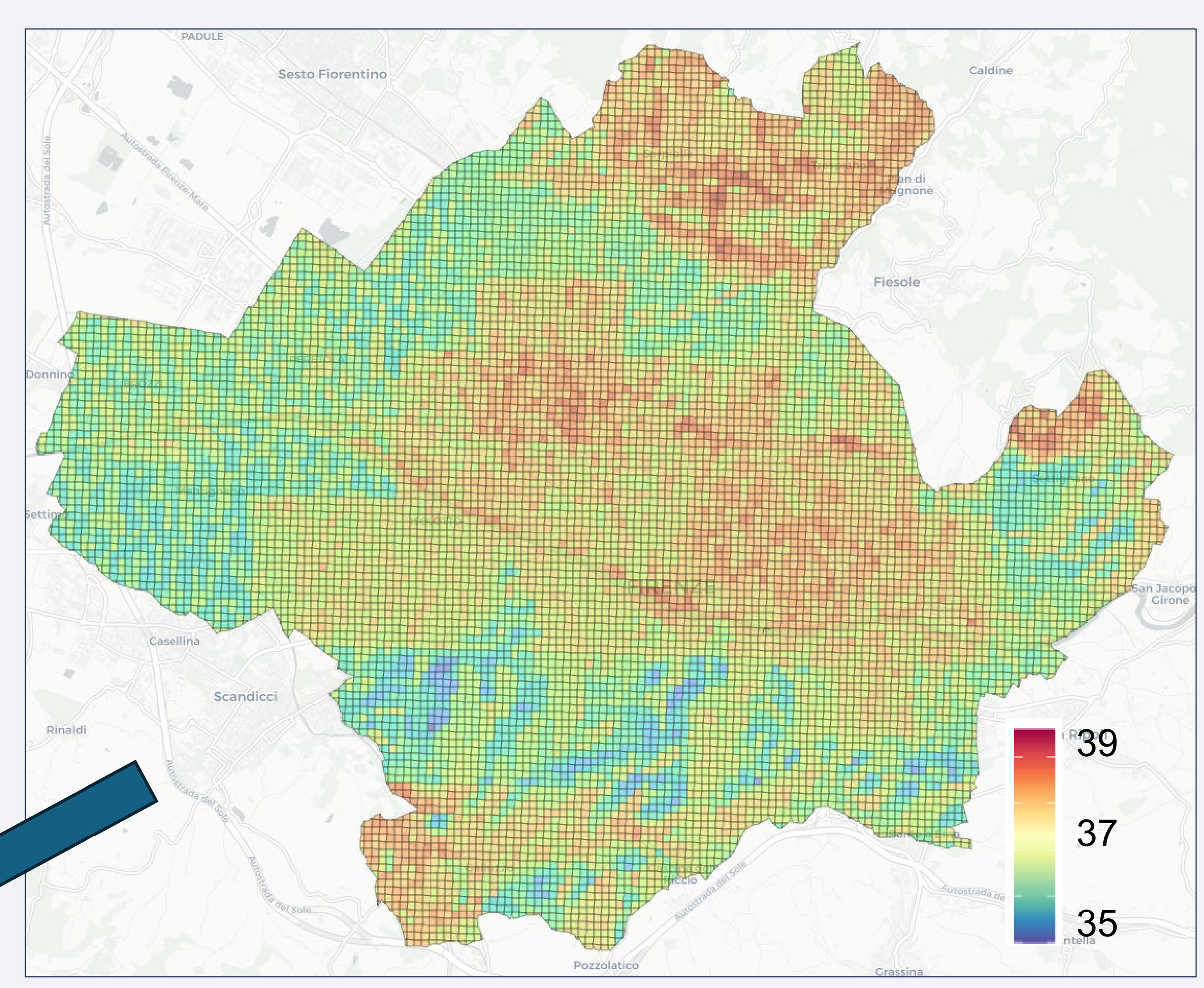
Precipitation

For the year 2022, we executed the model for estimate minumun and maximux temperature in the summer and winter seasons and performed cross-validation to calculate measures of model validity, such as R^2, spatial R^2, temporal R^2, and RMSE.

Results and conclusions

Stage 1	R^2	RMSE
Winter/Summer 2022	0.97;0.99	< 1°C

Stage 2	R^2	Spatial R^2	Temporal R^2	RMSE
Tmax-Winter 2022	0.92	0.89	0.93	1.16 °C
Tmax-Summer 2022	0.90	0.78	0.94	1.43 °C
Tmin-Winter 2022	0.75	0.57	0.82	1.92 °C
Tmin-Summer 2022	0.78	0.66	0.85	1.60 °C



Tmax temperature estimated in Florence, 1st July 2022

The study offers a tool to address risk from extreme heat, aiding targeted interventions in highly exposed and vulnerable areas.

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