Interreg Europe

Co-funded by the European Union

SATSDIFACTION

The Interreg Europe SATSDIFACTION Project

Monitoring of Urban sustainable development

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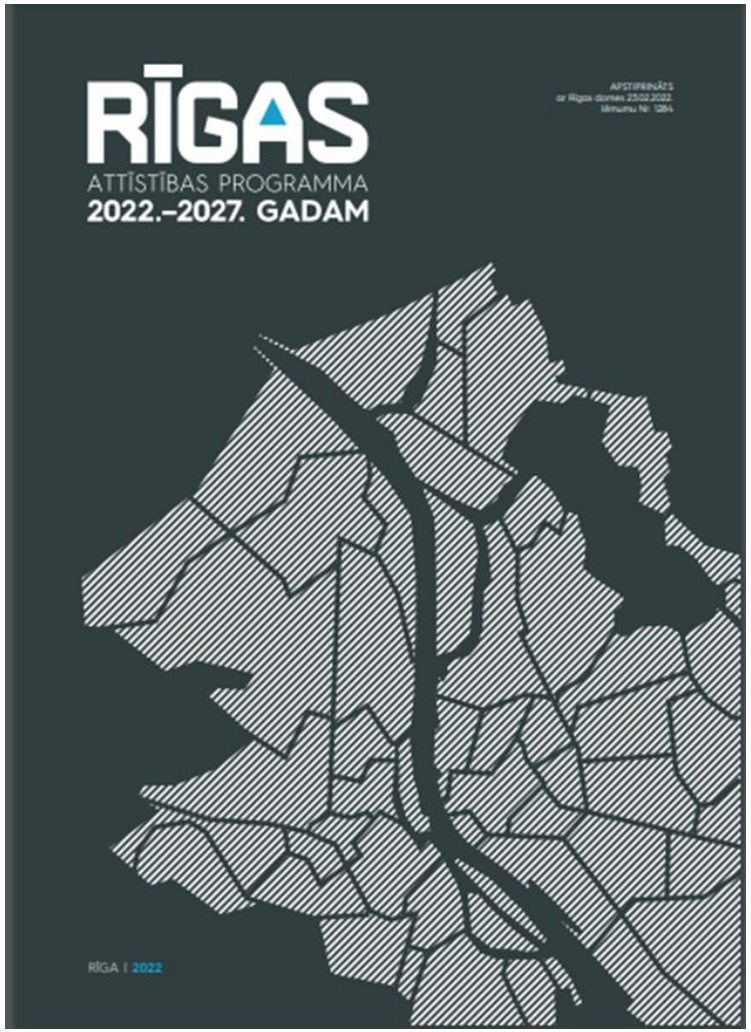
11.09.2025, RIGA

RIGA CITY DEVELOPMENT PROGRAMME 2022 - 2027

IMPROVE A MONITORING OF
- GREEN INFRASTRUCTURE
- «HEAT ISLAND» EFFECT



STRATEGIC PART
9 PRIORITIES
60 TASKS
252 indicators
PERMANENT

ATCTION PLAN

INVESTMENT PLAN

UPDATED EVERY YEAR

YEARLY MONITORING REPORT

Priorities of the Development Programme

- Urban Environment
- Governance
- Mobility
- Environment and Climate
- Society
- Housing
- Education
- Cultural Environment
- Competitiveness

Strategic monitoring

Parties involved in strategic monitoring

24 RD institutions and departments

Residents' opinion

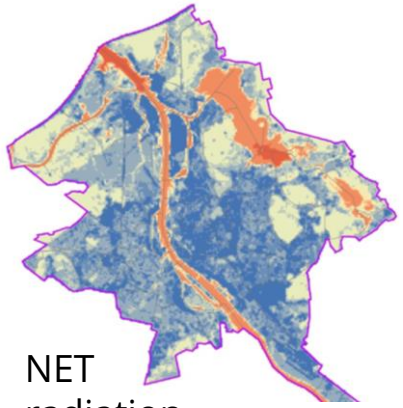
Industry experts

External sources

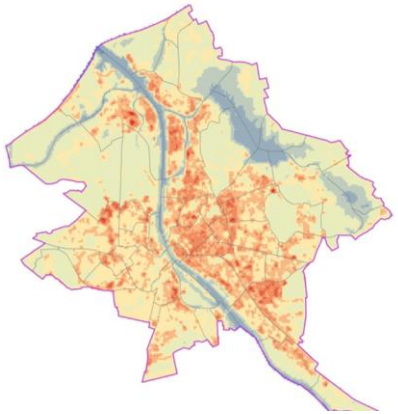
SATELLITE DATA I

City microclimate 2016

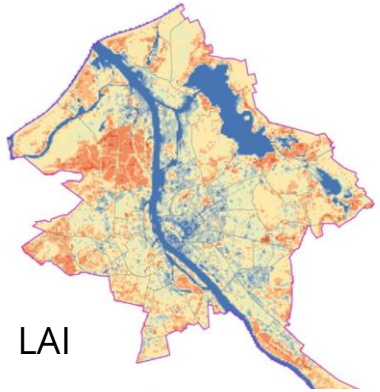
Only one picture was usefull due to cloudiness
Resolution 30x30 m



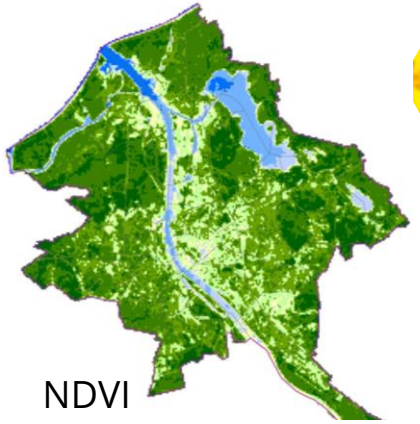
NET radiation



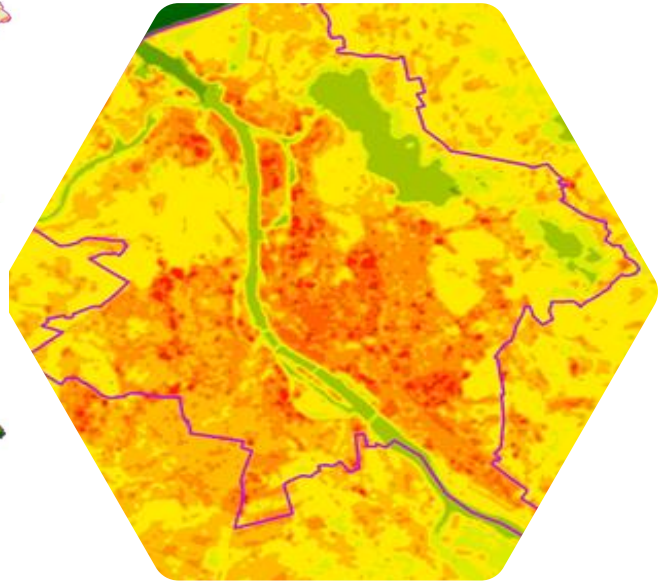
Surface temperature



LAI



NDVI



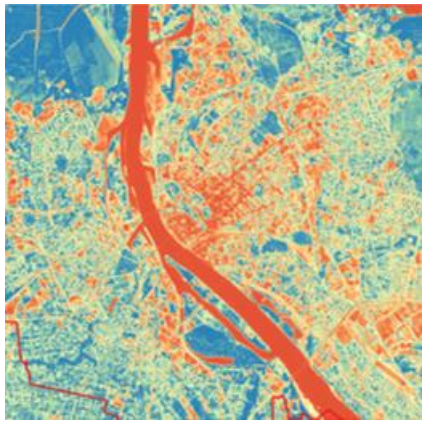
Using Landsat 7 image

SATELLITE DATA II

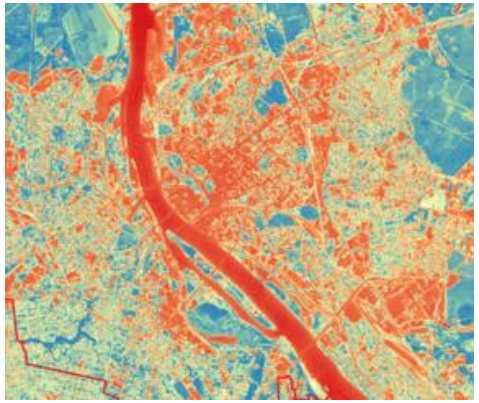
Satellite data for monitoring 2022

For green areas moitoring:
- NDVI
- MSAVI2
- LAI
- NDMI

For heat island effect moitoring:
- Sentinel- 3 (SLSTR)



LAI

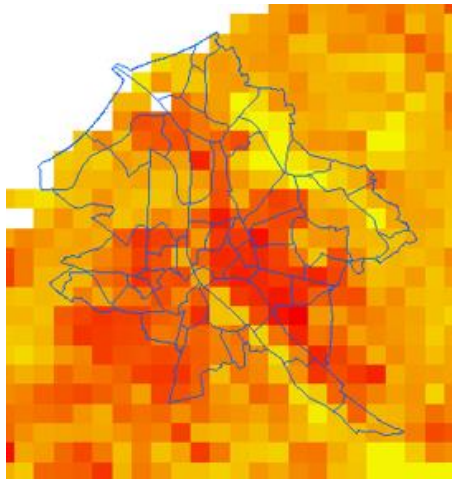


NDVI

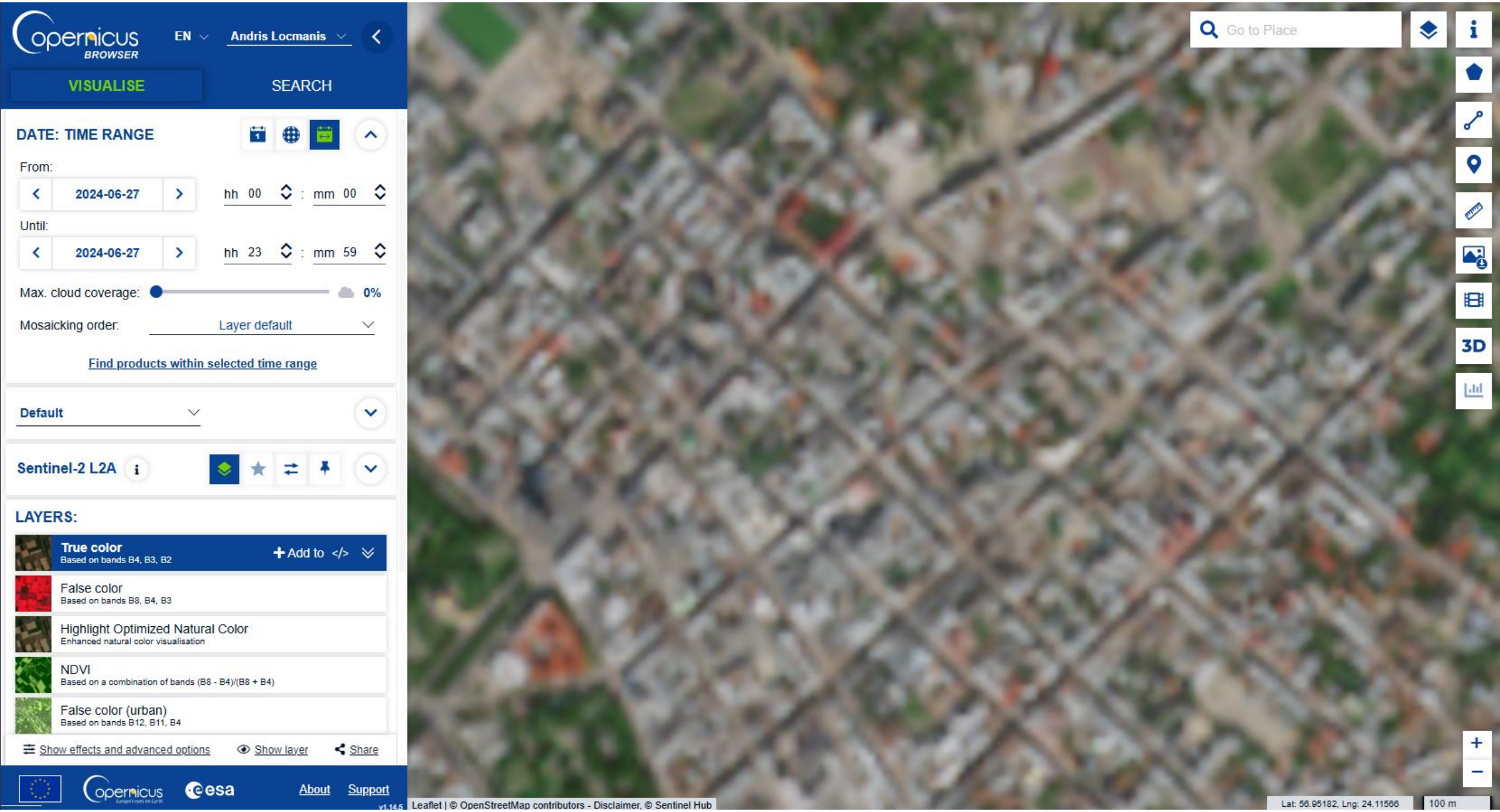
Vegetation difference (LAI)

Using Sentinel-2 images

NDBI



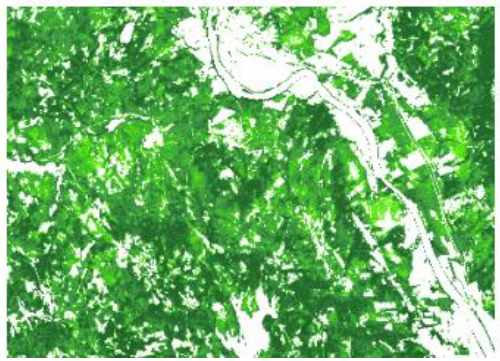
Thermal data Sentinel-3


Copernicus BROWSER
EN
Andris Locmanis
VISUALISE
SEARCH
DATE: TIME RANGE
From:
2024-06-27
hh 00 : mm 00
Until:
2024-06-27
hh 23 : mm 59
Max. cloud coverage:
0%
Mosaicking order:
Layer default
Find products within selected time range
Default
Sentinel-2 L2A
LAYERS:
True color
Based on bands B4, B3, B2
Add to
False color
Based on bands B8, B4, B3
Highlight Optimized Natural Color
Enhanced natural color visualisation
NDVI
Based on a combination of bands (B8 - B4)/(B8 + B4)
False color (urban)
Based on bands B12, B11, B4
Show effects and advanced options
Show layer
Share
About
Support
Go to Place
3D
Leaflet | © OpenStreetMap contributors - Disclaimer, © Sentinel Hub
Lat: 56.95182, Lng: 24.11566
100 m

Tree Cover Density 2018 (raster 10 m, 100 m), Europe, yearly

General info

Download



Provides at pan-European level in the spatial resolution of 10 m and 100 m the level of tree cover density in a range from 0% to100% for the 2018 reference year.

Validation status

Validated

Dataset citation

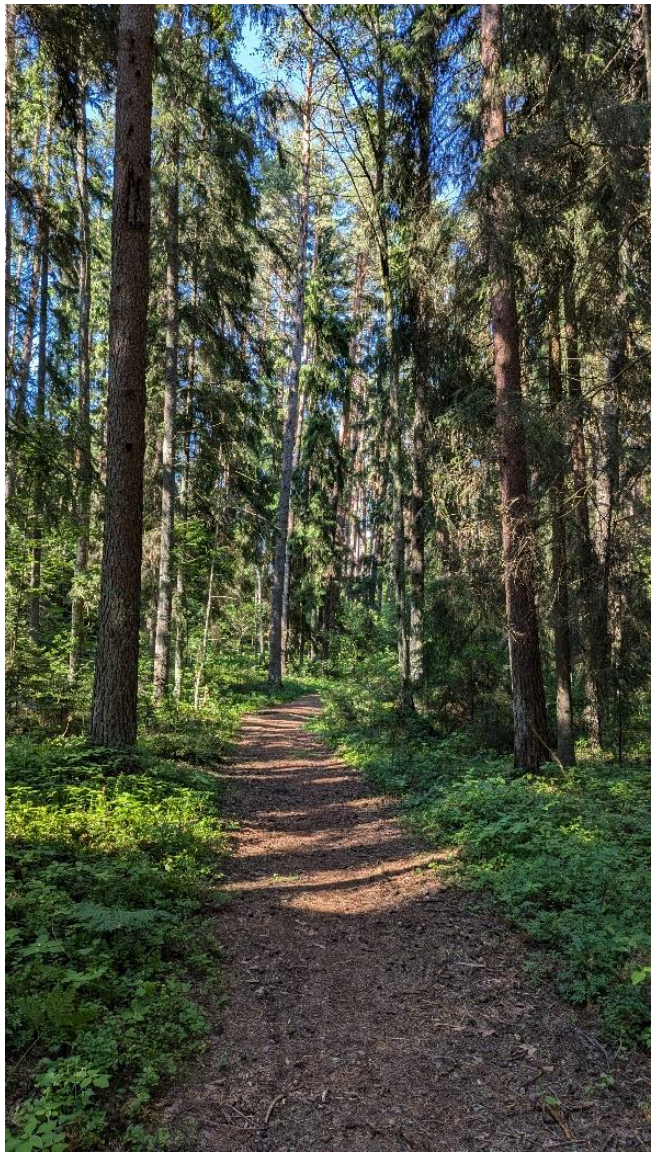
- **DOI (raster 10 m):** https://doi.org/10.2909/e677441e-fb94-431c-b4f9-304f10e4dfd8
- **DOI (raster 100 m):** https://doi.org/10.2909/4dc35722-09ce-427f-9a1b-775a8640da27

Forests in Latvia

Total area of forest stands 3 240 000 ha (50.2% of land area)

With different terminologies even 53 or 55.7% of total land area

According to NFI, over the past two decades, area of forests have expanded by around 66.6 thousand hectars (+2.1%)



Forests in Riga

Rīgas meži manage about 4464 hectares of forest land within Riga city.

Of this, approximately 2270 hectares are actual forested areas, forming the core urban forest in the city.

Additional green spaces under their care include 446 hectares of public greenery and 367 hectares of Mežaparks

Why it’s necessary to map all trees

Existing databases cover mainly planted/managed trees, not all greenery;

Private yards, abandoned lots, and natural regeneration often missing from records;

Needed for urban heat island mitigation and climate planning;

Supports air quality, carbon storage, and biodiversity assessments;

Helps detect inequalities in access to green spaces;

Important for risk management (storm damage, power lines, infrastructure);

Enables change detection to monitor tree loss or new growth over time.

Classification

Image classified in 4 classes:

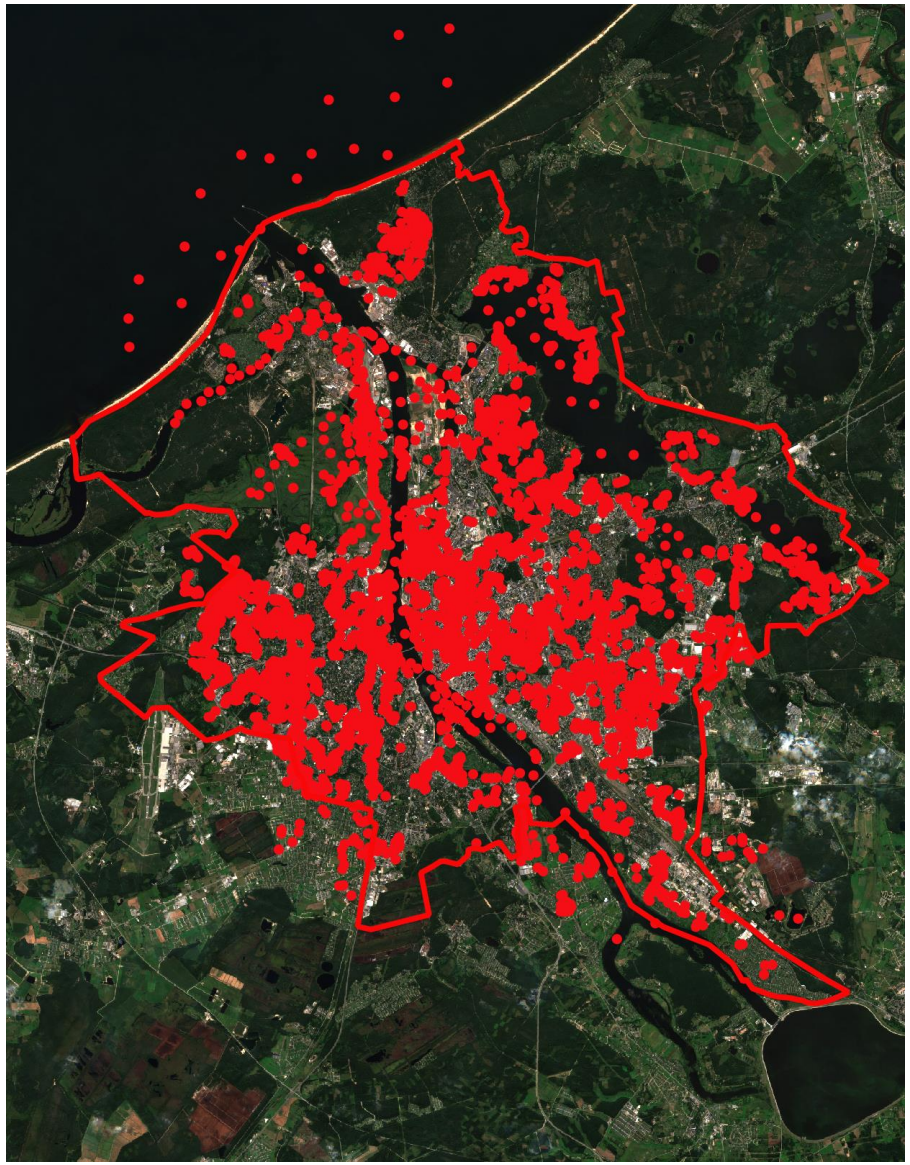
Water (1345 labels);

Built-up areas (807);

Grassland (1360);

Tree cover (1176).

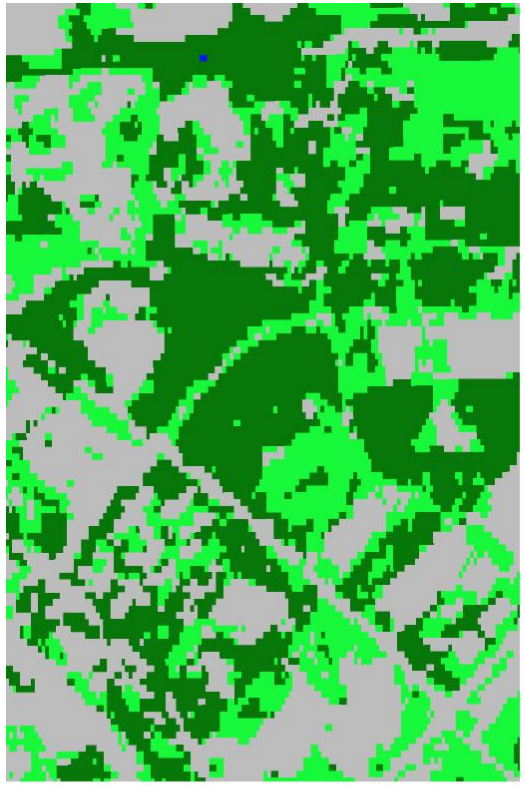
XGBtree algorithm from Caret library in R.

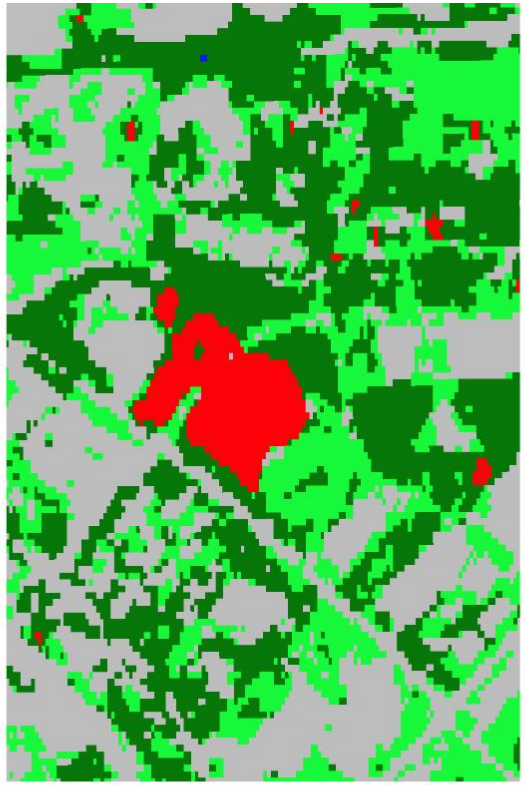


Results

```
          Reference
Prediction   1   2   3   4
         1 234   1   7  14
         2   0 158   0   1
         3  14   1 251  26
         4  21   1  14 194

Overall Statistics

               Accuracy : 0.8933
                 95% CI : (0.8717, 0.9123)
    No Information Rate : 0.2903
    P-Value [Acc > NIR] : <2e-16

                  Kappa : 0.8559

 Mcnemar's Test P-Value : 0.1557

Statistics by Class:

                     Class: 1 Class: 2 Class: 3 Class: 4
Sensitivity            0.8699   0.9814   0.9228   0.8255
```

Change detection





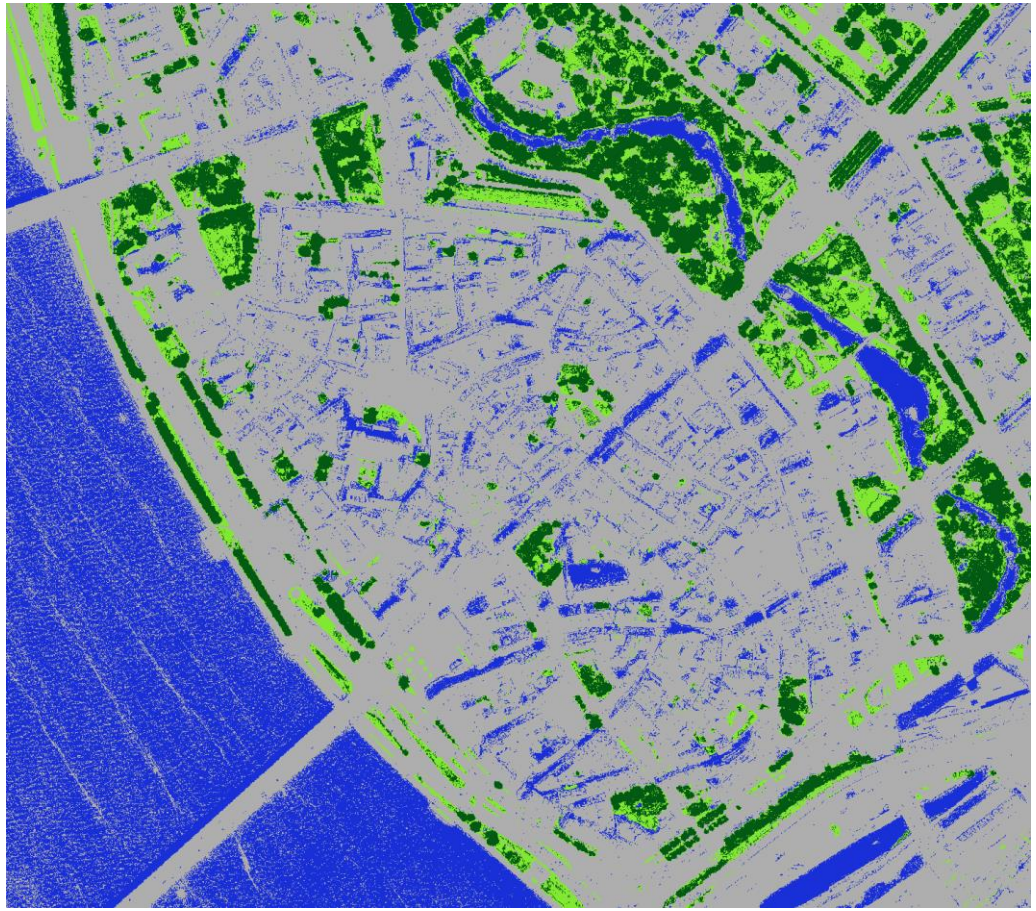
Land Use
Forest
Water
Built-up areas
Grassland

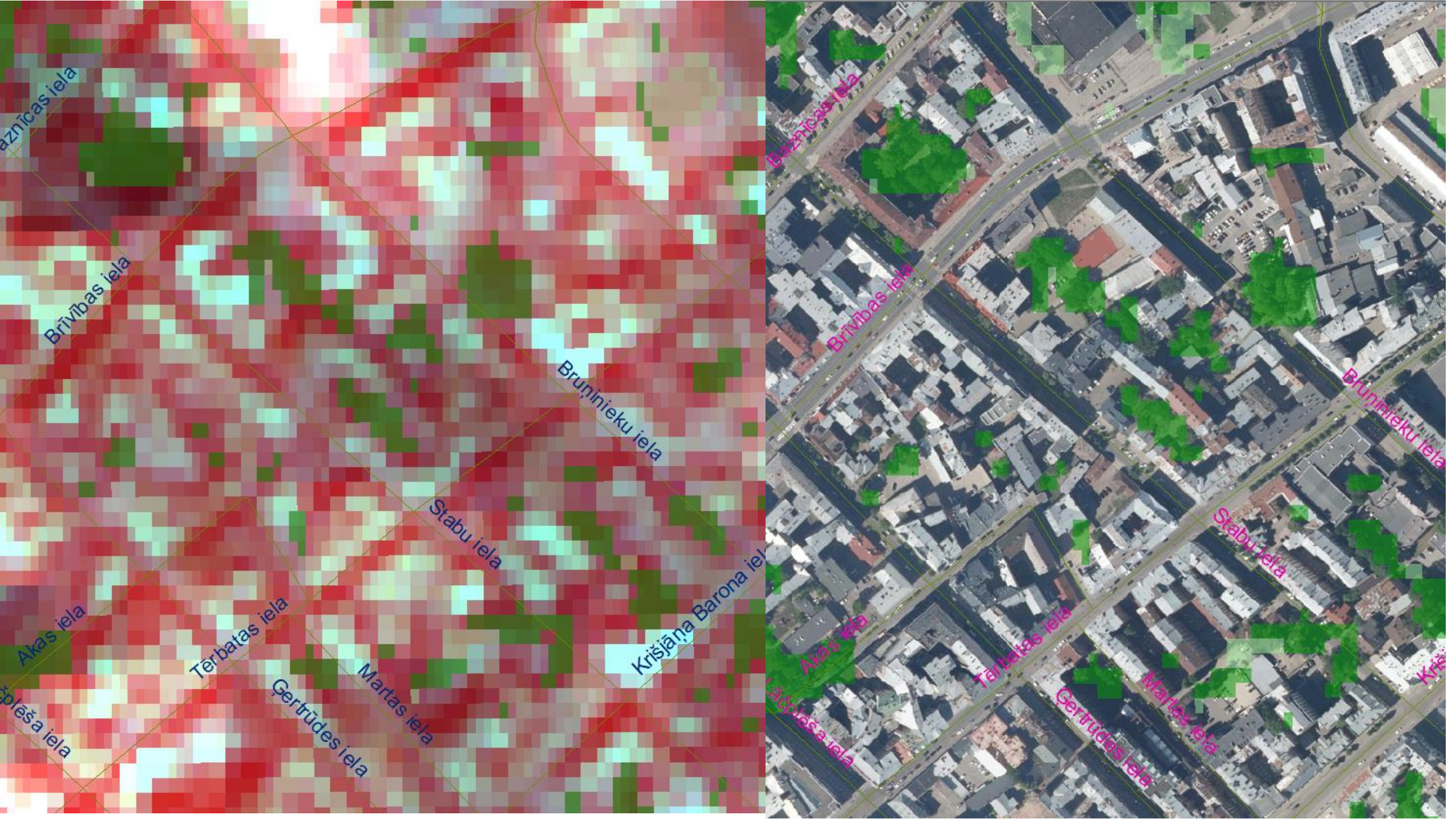
0 250 500 m

High resolution MS data from Airbus

Results

```
Confusion Matrix and Statistics

          Reference
Prediction  1  2  3  4
         1 26  5  0  0
         2  5 50  3  0
         3  0  0 40  4
         4  0  0  1 43

Overall Statistics

               Accuracy : 0.8983
                 95% CI : (0.844, 0.9386)
    No Information Rate : 0.3107
    P-Value [Acc > NIR] : < 2.2e-16

                  Kappa : 0.8625

 Mcnemar's Test P-Value : NA

Statistics by Class:

                     Class: 1 Class: 2 Class: 3 Class: 4
Sensitivity            0.8387   0.9091   0.9091   0.9149
```




Brīvības iela
Bruņinieku iela
Stabu iela
Akas iela
Tērbatas iela
Ģertrūdes iela
Martas iela
Krišjāņa Barona iela
Bruņinieku iela
Stabu iela
Akas iela
Tērbatas iela
Ģertrūdes iela
Martas iela

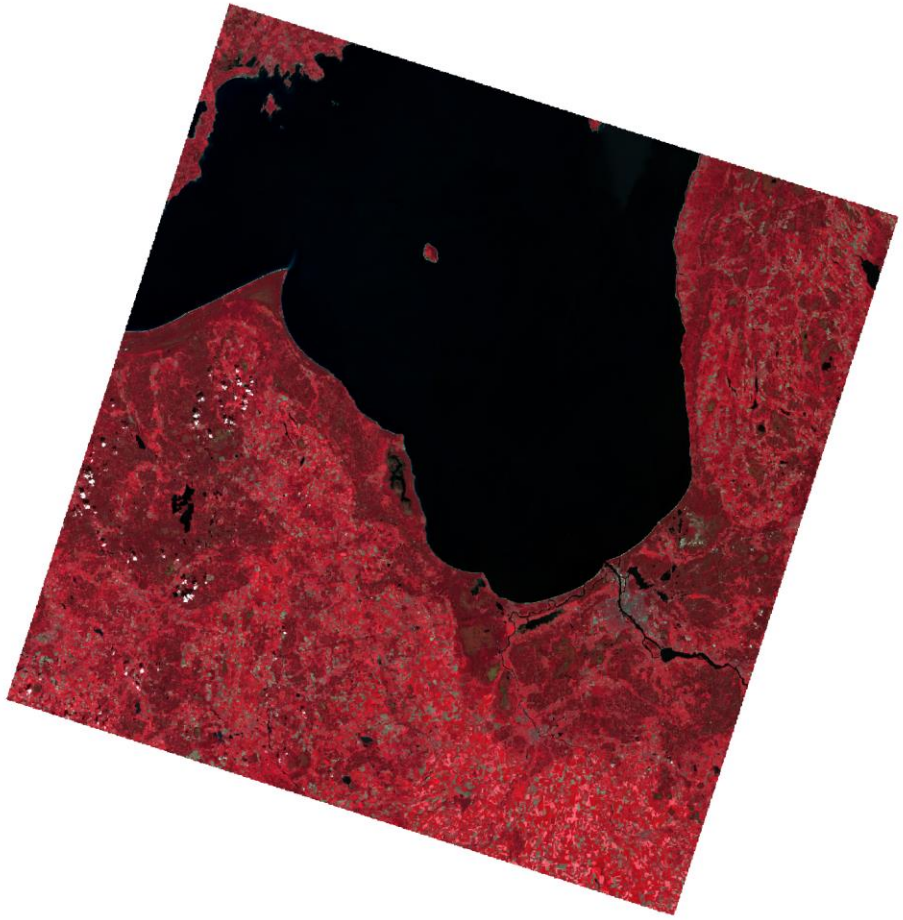
Example with Hi-RES images

Urban Heat Island Mapping with Landsat Satellite Data

What is an Urban Heat Island (UHI)?

Phenomenon where urban areas are significantly warmer than surrounding rural areas.

Caused by dense infrastructure, reduced vegetation, and heat retaining surfaces.



Why Use Landsat for UHI Mapping?

Thermal Infrared Sensor (TIRS) on Landsat 8–9 provides surface temperature data.

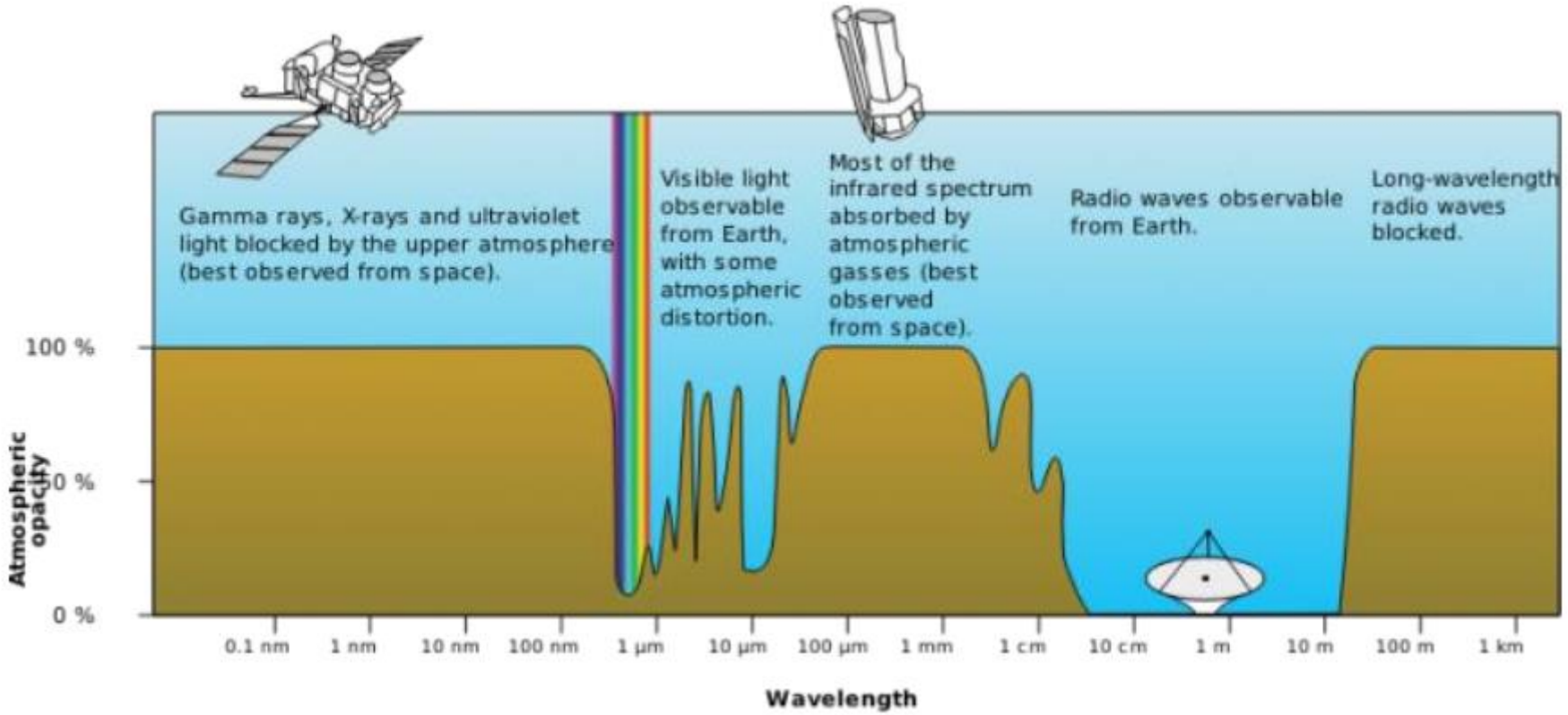
Long archive: data available since 1970s for historical UHI studies.

30 m resolution (thermal bands resampled) enables neighborhood-scale mapping.

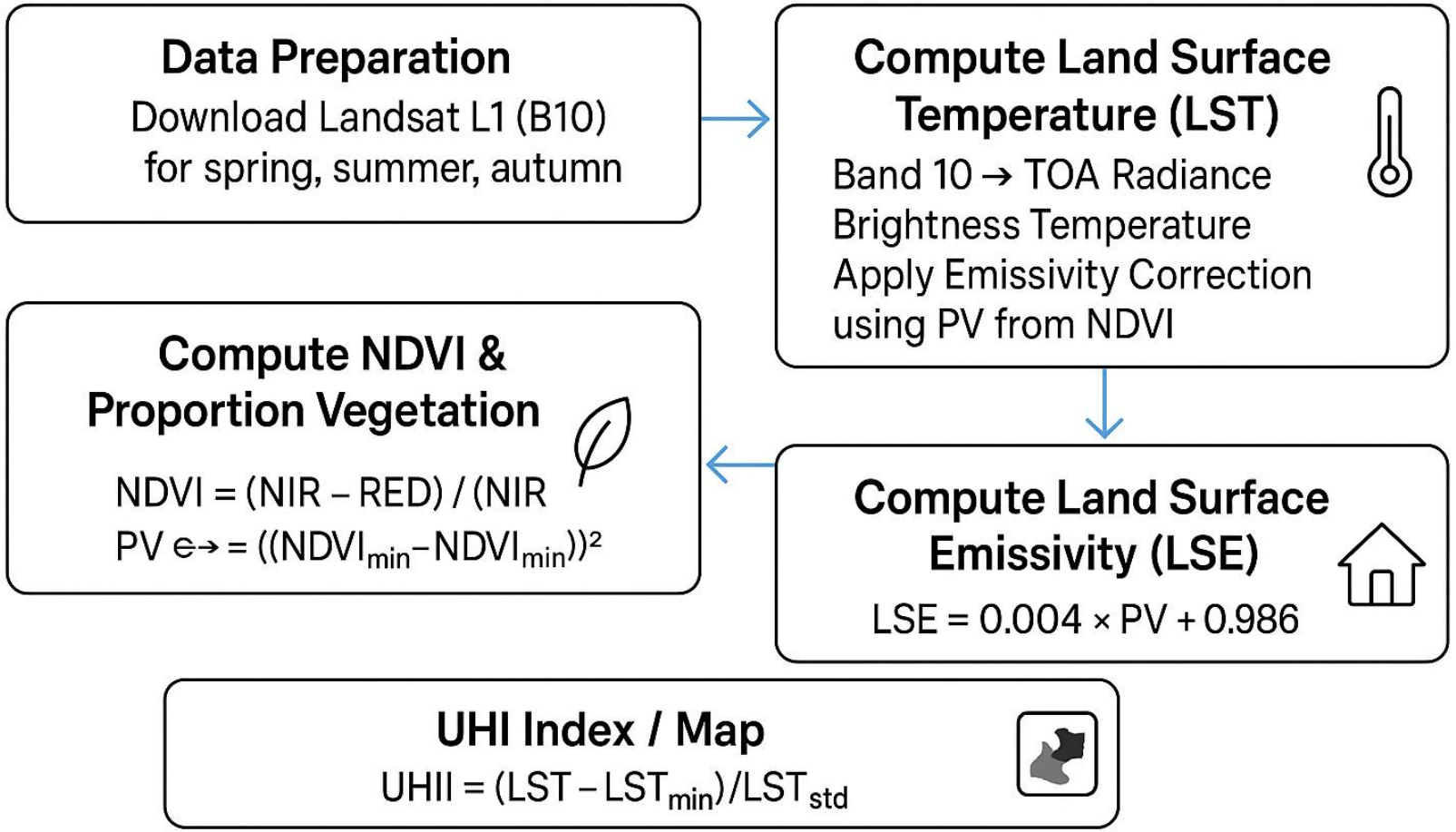
Freely available global data for consistent monitoring.

Remote Sensing of Land Surface Temperature

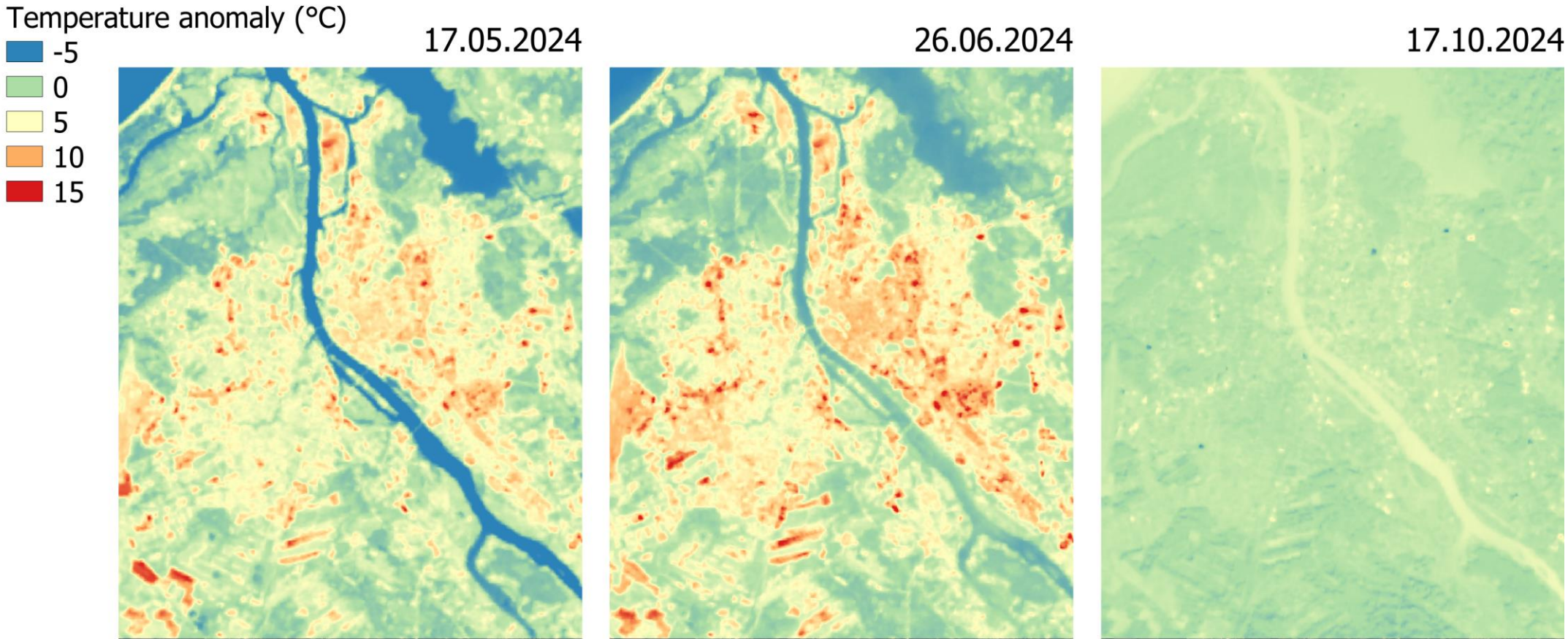
Atmospheric window: Between approximately 10–12 micrometers (μm) the atmosphere has relatively low absorption of IR radiation emitted by the land surface. Therefore, this spectral region is used to derive land surface temperature (LST).



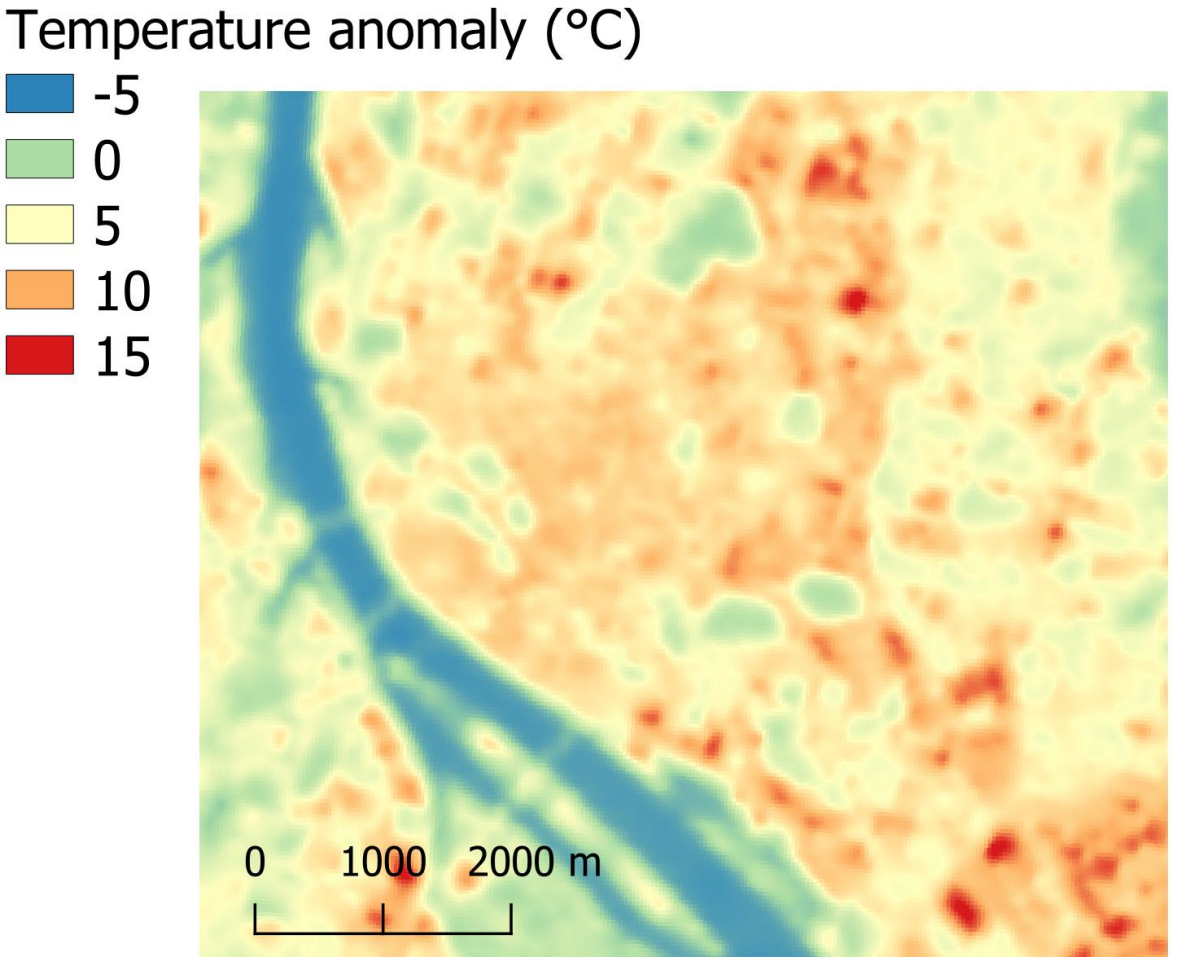
Urban Heat Island (UHI) Mapping – Workflow



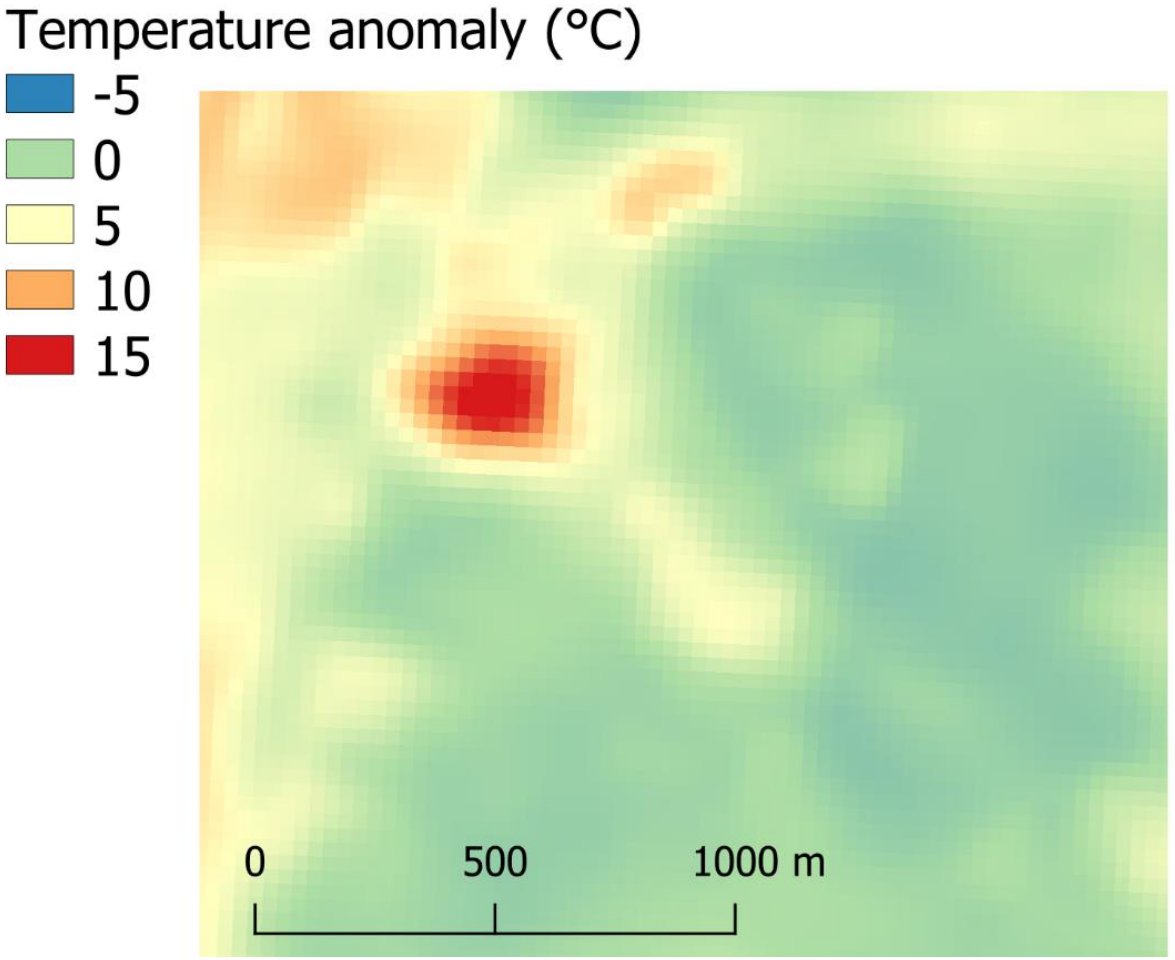
Seasonal Dynamics of Urban Heat Island Effect



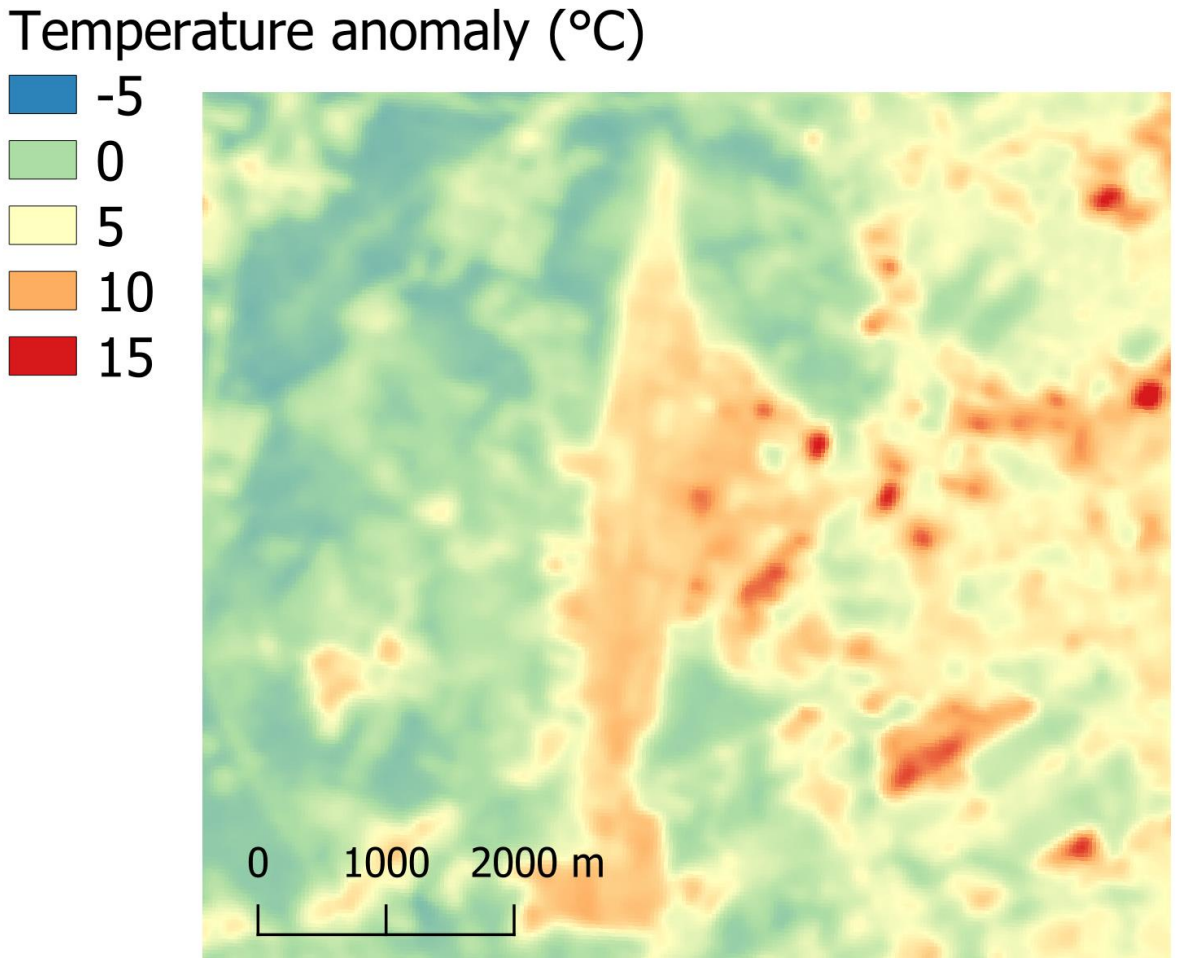
Case Examples: UHI Patterns across landscape

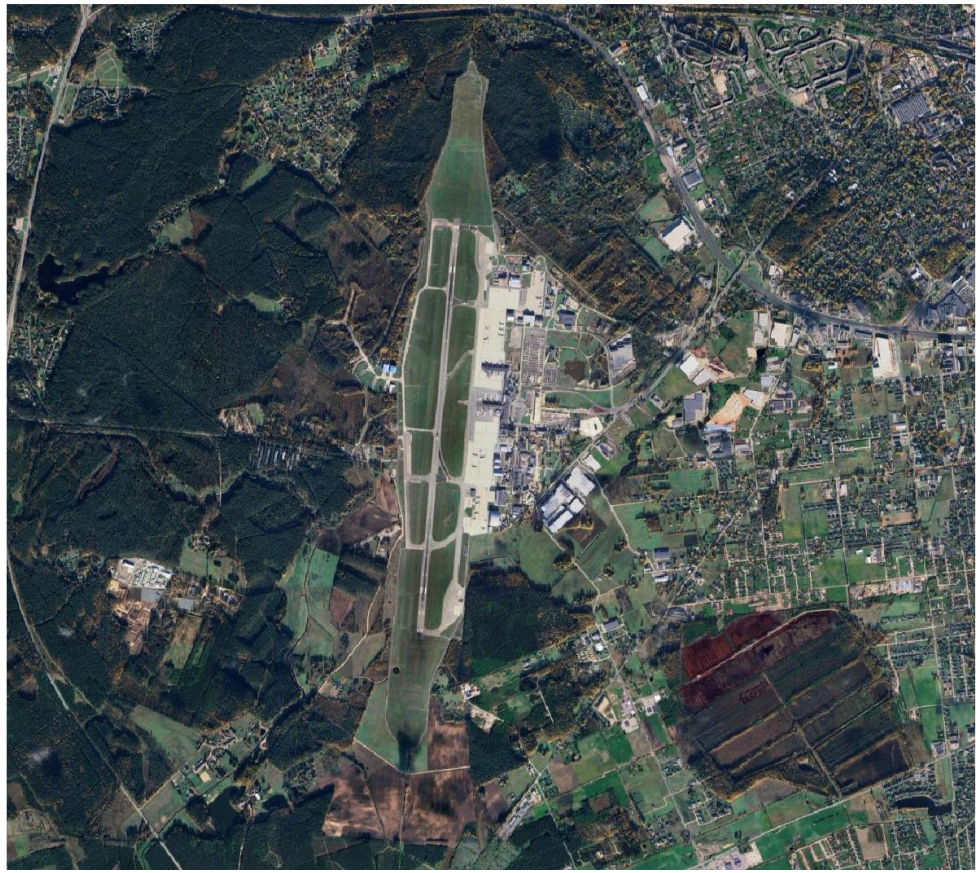


Case Examples: UHI Patterns across landscape

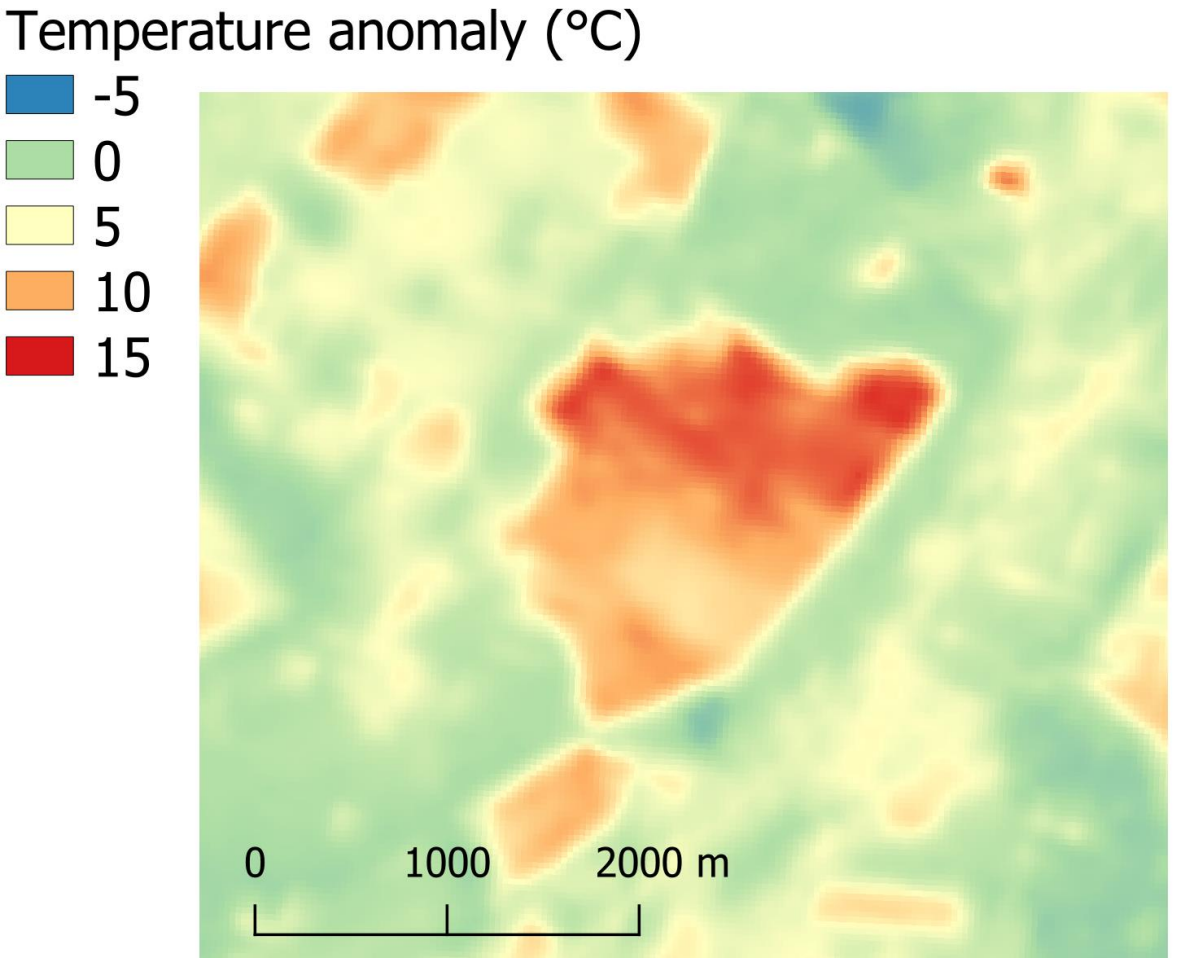


Case Examples: UHI Patterns across landscape

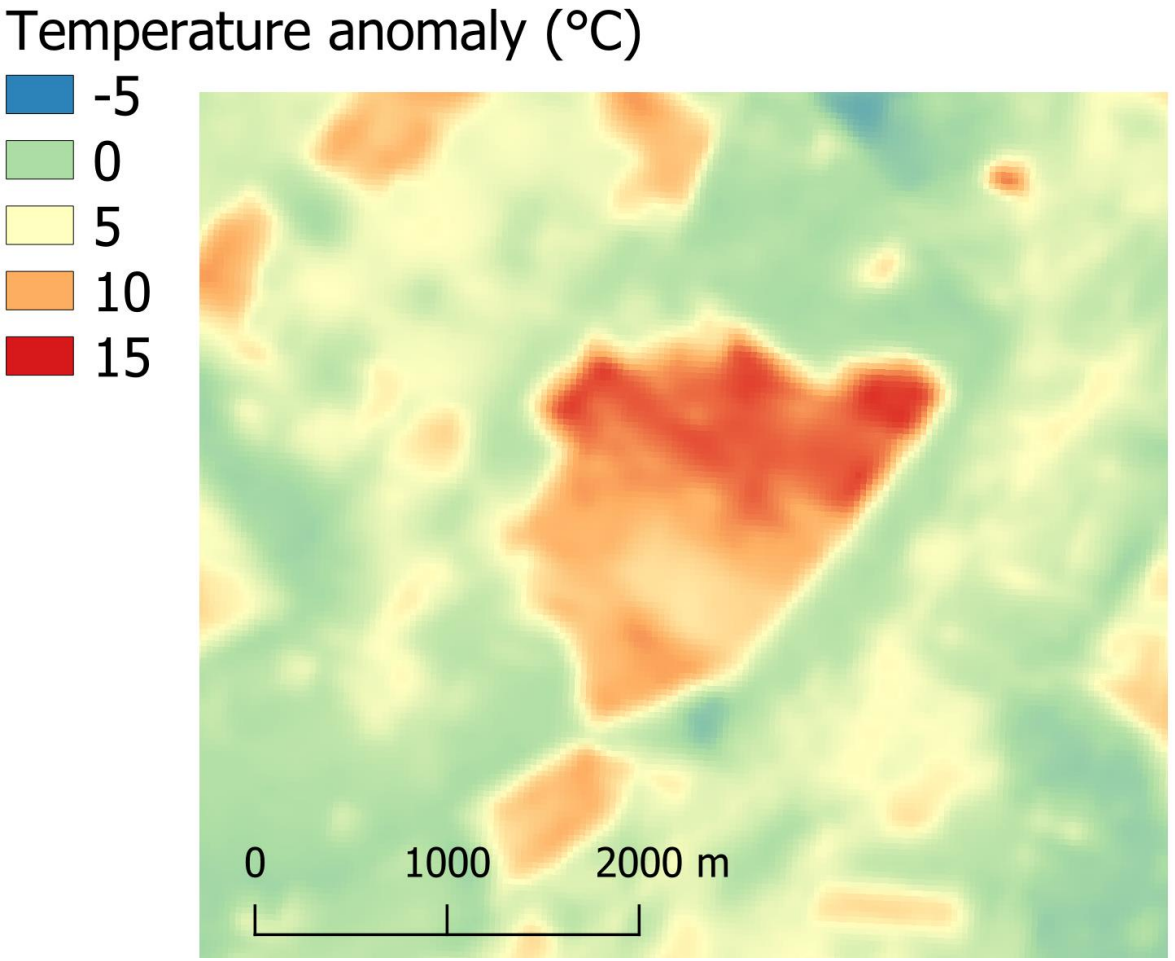




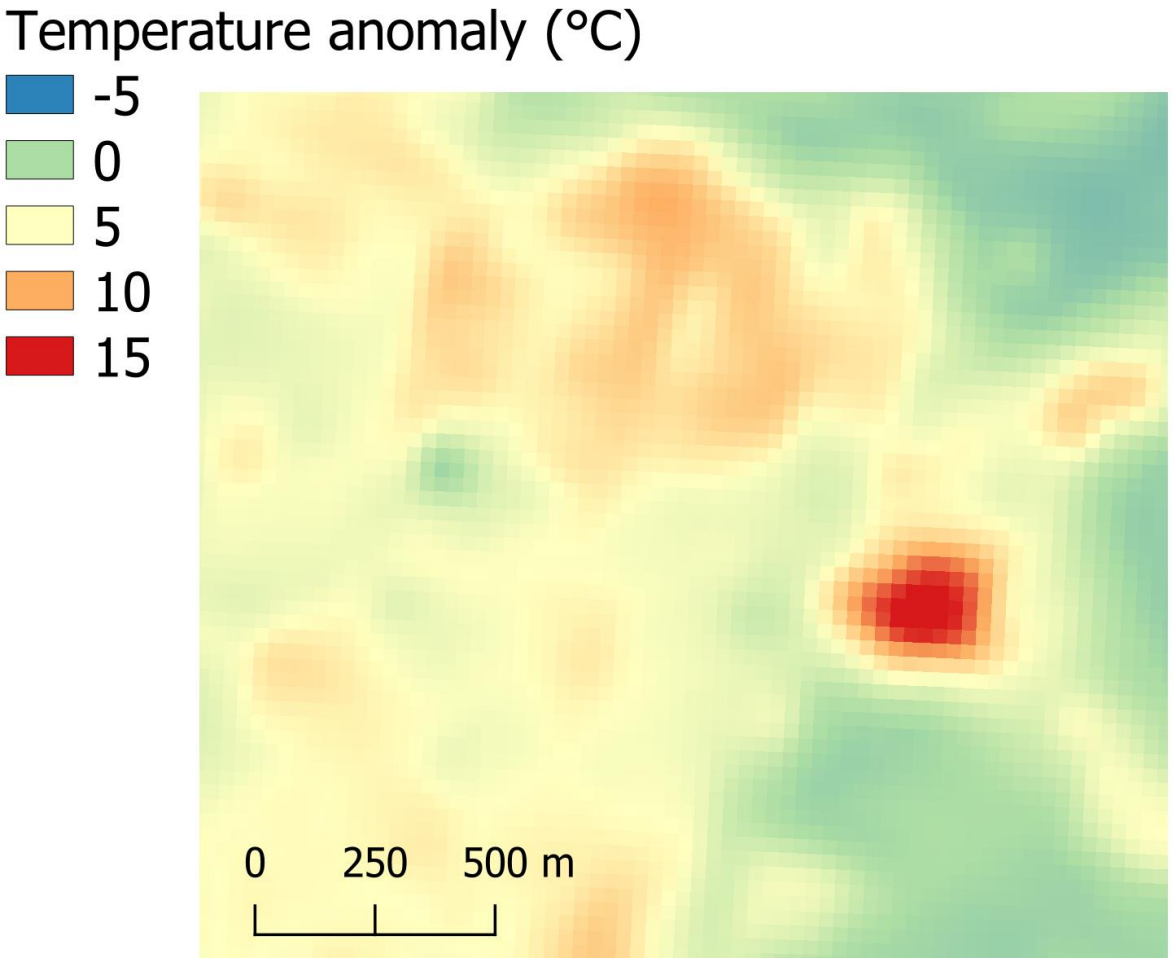
Case Examples: UHI Patterns across landscape

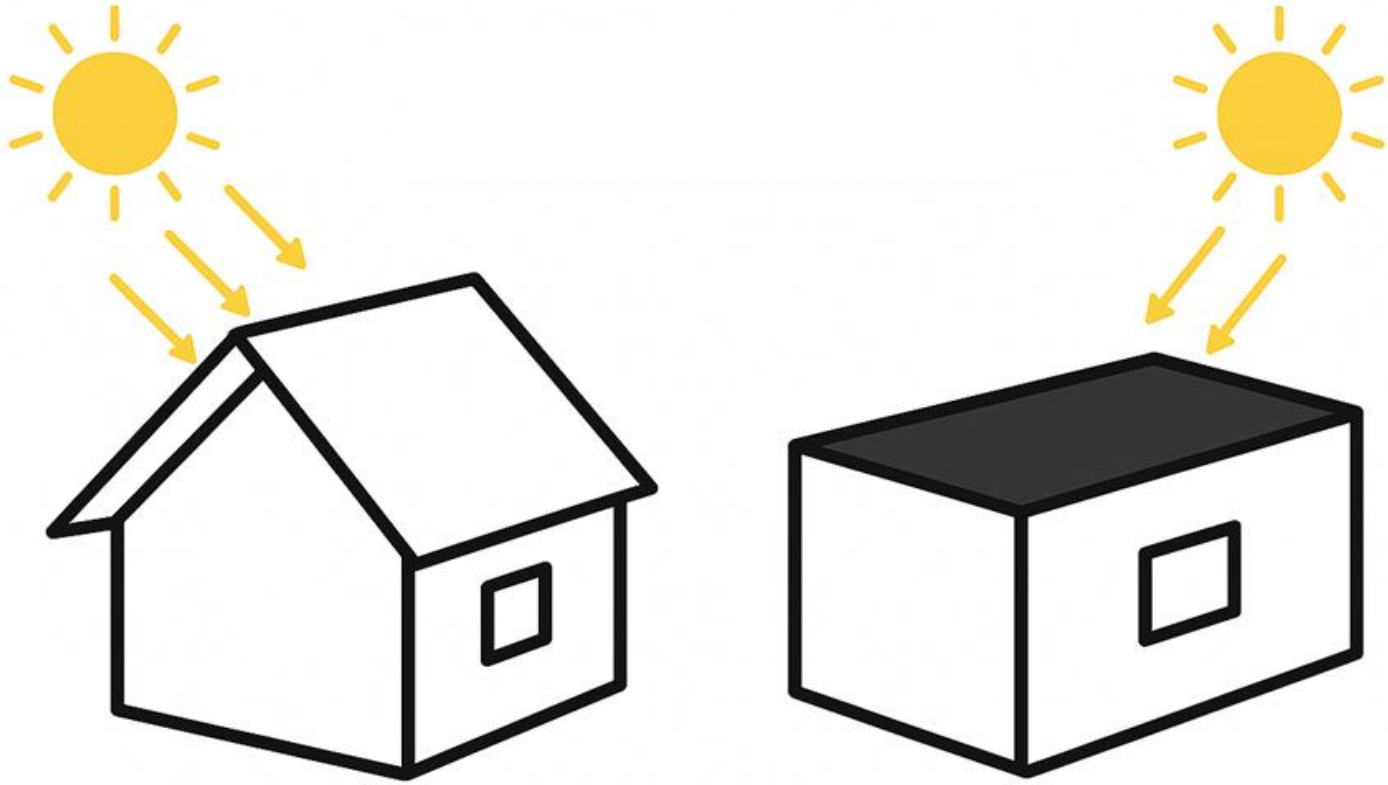


Case Examples: UHI Patterns across landscape



Case Examples: UHI Patterns across landscape





HIGH ALBEDO

GOOD FOR UHI

GABLE ROOF

LOW ALBEDO

BAD FOR UHI

Concludions

- Urban monitoring with satellite data is a key topic at the European level. The main challenge is Sentinel image resolution, which is often too low for urban areas. However, as several projects address similar issues, we see a great opportunity to compare results and identify the best solutions.
- Clear communication with users about the purpose and interpretation of results is essential.