



Mediterranean Regional Information Network Priority topics: Urban, Climate

Sustainable Urban Development

Main Challenges:

- Urbanization
- Pollution
- Climate Change
- Disaster vulnerability



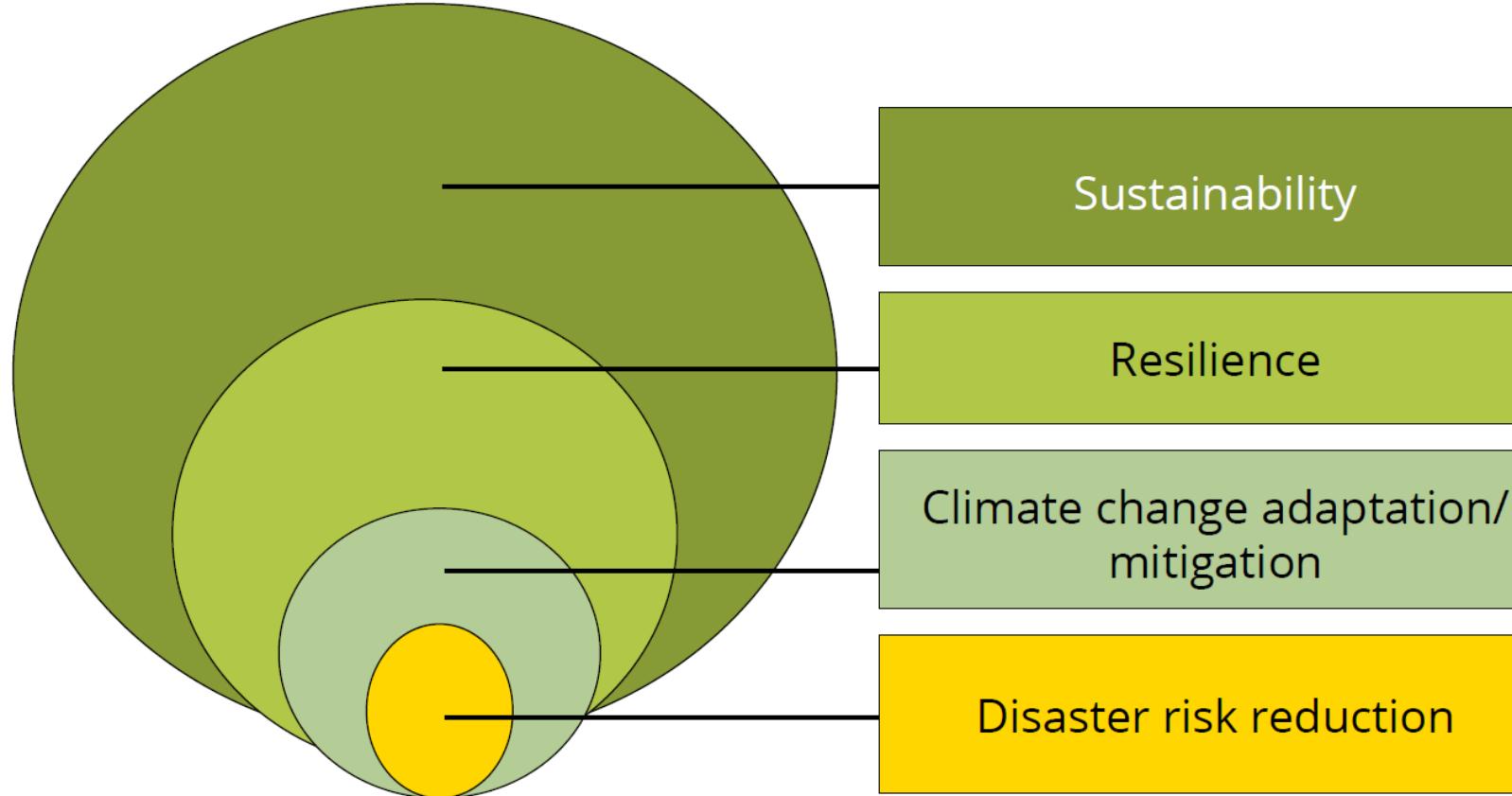
SUSTAINABLE
DEVELOPMENT **GOALS**
KNOWLEDGE PLATFORM



Sustainable Development Goal 11
Make cities and human settlements
inclusive, safe, resilient and sustainable



Sustainable Urban Development



Source: Robrecht and Morchain, 2012.
EEA report, 2016

Earth Observation for Urban Resilience

The image shows a screenshot of the Copernicus website. At the top, there is a navigation bar with links for Media, Events, News, Contact, Log in, and English. Below the navigation bar is a large satellite image of Europe. Overlaid on the image are several text elements: "Europe's eyes on Earth", "Looking at our planet and its environment", "For the ultimate benefit of all European citizens", "Copernicus In Situ – from analysis to action", and a note about Sentinel-3 data. A white circle highlights a cluster of four puzzle pieces (green, blue, red, orange) in the center of the map. Lines connect these puzzle pieces to six service icons at the bottom: Atmosphere (blue square), Marine (blue square), Land (green square), Climate Change (red square), Security (teal square), and Emergency (orange square). The word "URE" is partially visible on the right side of the map.

Media Events News Contact | Log in English

Services Opportunities Access to Data How to Library Use Cases About Copernicus

Europe's eyes on Earth

Looking at our planet and its environment

For the ultimate benefit of all European citizens

Copernicus In Situ – from analysis to action

Europe - Copernicus Sentinel-3 data (2017), processed by Sinergise and ESA

Atmosphere

Marine

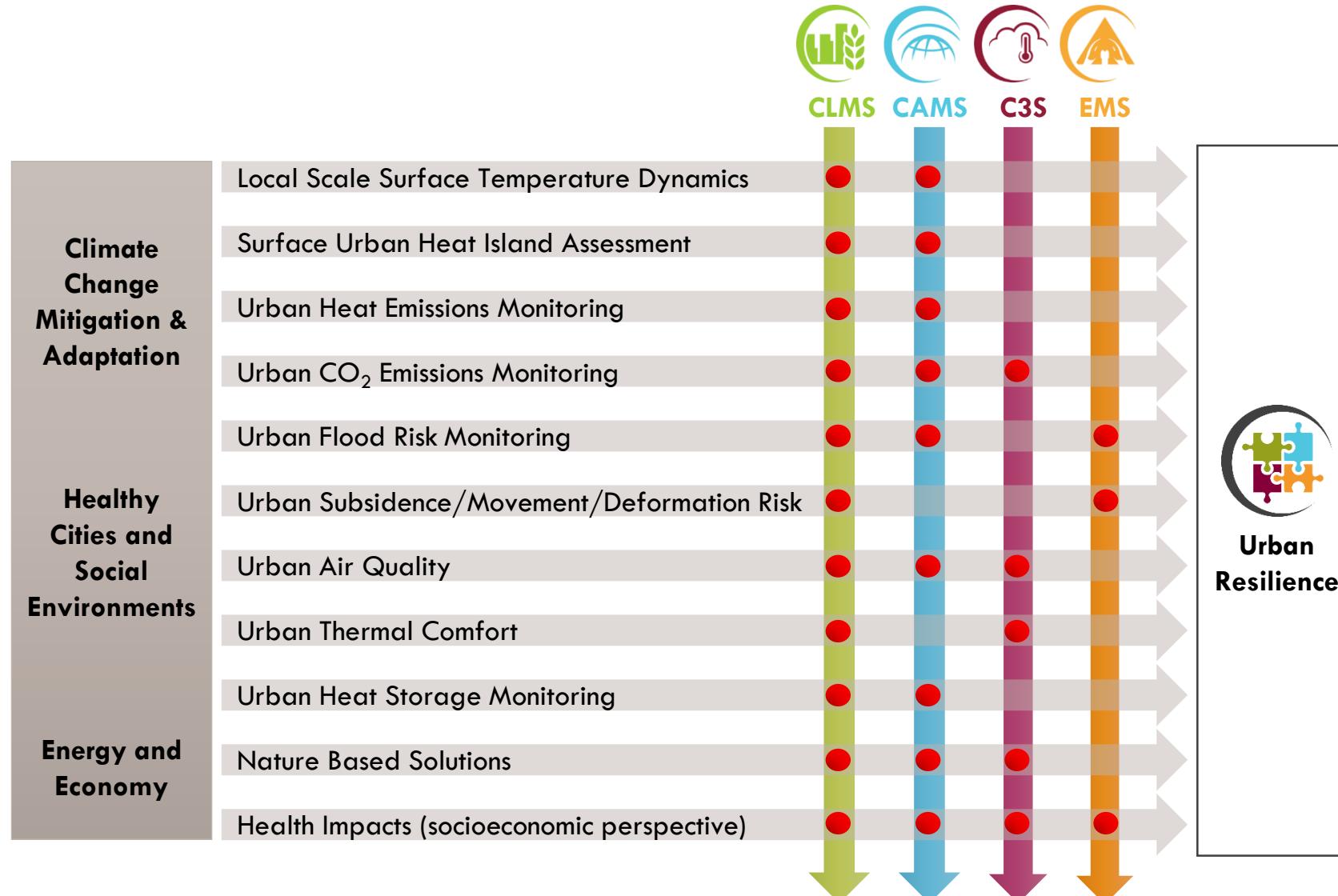
Land

Climate Change

Security

Emergency

Earth Observation for Urban Resilience



Remote Sensing Lab



Recent activities towards urban sustainability:

- › Urban Heat Fluxes Monitoring from Space
- › Urban CO₂ Flux monitoring and source attribution
- › Urban Metabolism Approach
- › Nature-based solutions
- › Tools and Indicators for sustainable Urban Planning



Urban Heat and CO₂ Fluxes Monitoring from Space

Lessons learned from H2020 URBANFLUXES Project

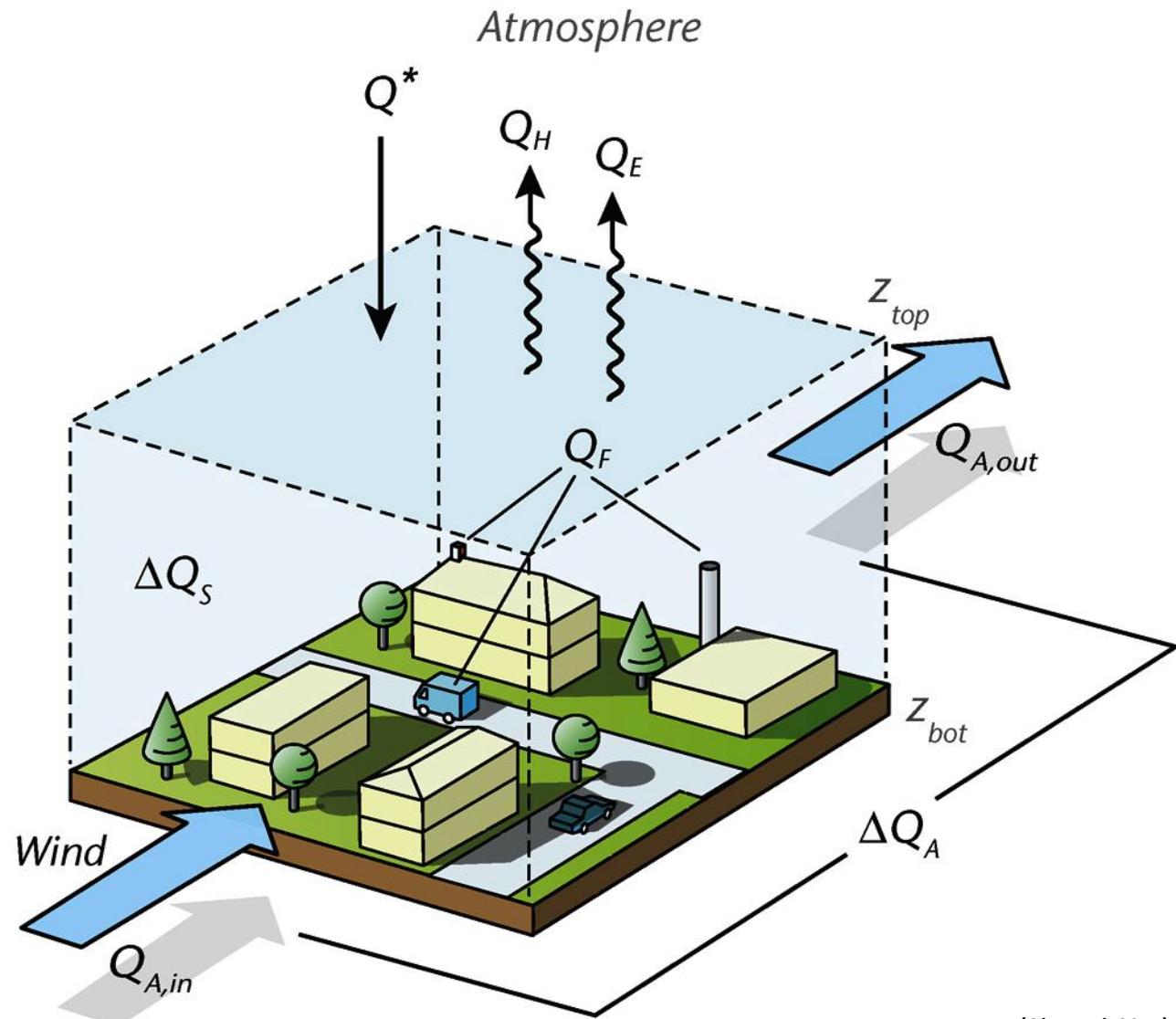




Urban Energy Budget

$$Q^* + Q_F = Q_H + Q_E + \Delta Q_S + \Delta Q_A$$

- › Q^* : Net all-wave radiation balance
- › Q_F : Anthropogenic heat flux
- › Q_H : Turbulent sensible heat flux
- › Q_E : Turbulent latent heat flux
- › ΔQ_S : Net change in heat storage
- › $\Delta Q_A = Q_{in} - Q_{out}$: Advective heat flux



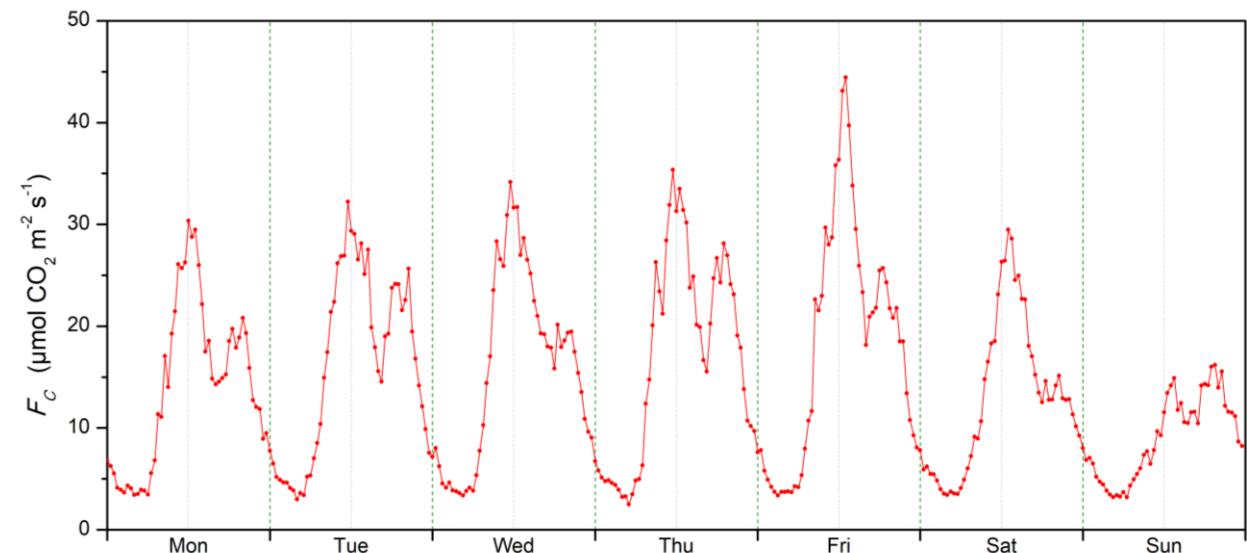
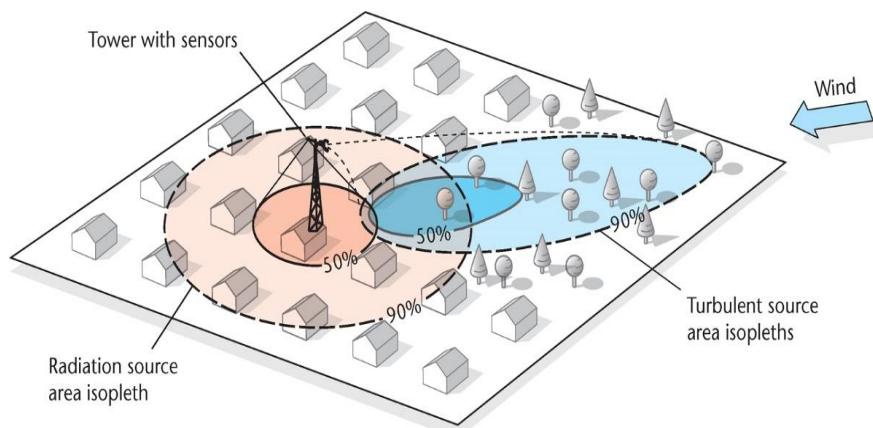
Long-term *in-situ* measurements in Heraklion

✓ Eddy Covariance (2016 – today)

- Sensible heat flux (Q_H)
- Latent heat flux (Q_E)
- Net all-wave radiation (Q^*)
- Carbon dioxide flux (F_{CO_2})

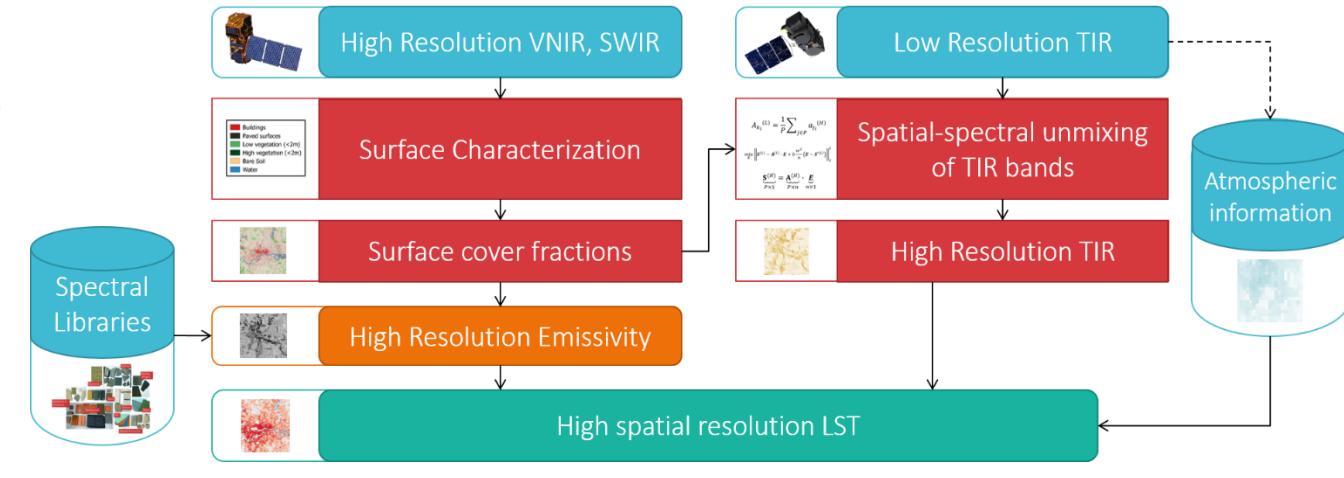
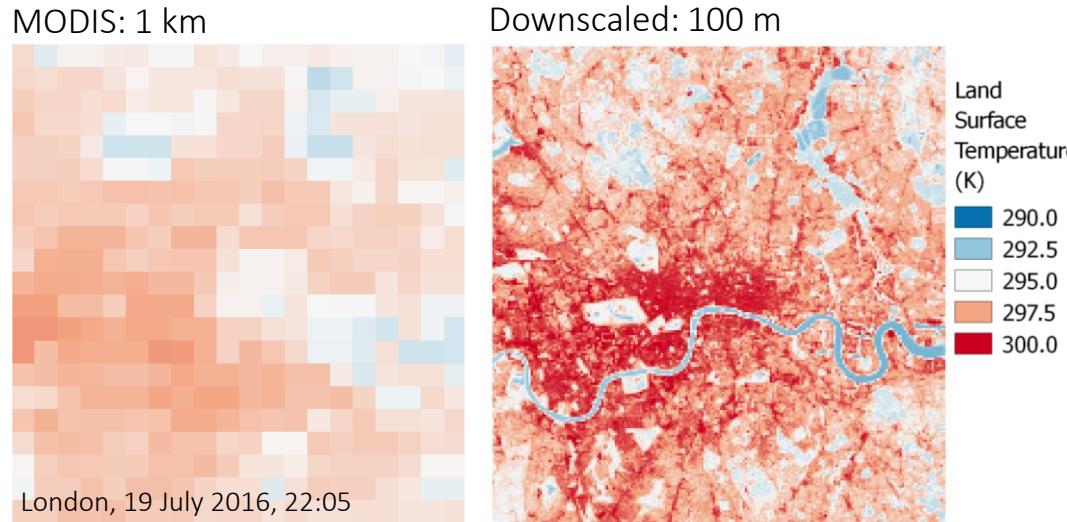
✓ Wireless Sensors Network (2015 – today)

- 15 on-line real-time intra-urban meteorological measurements

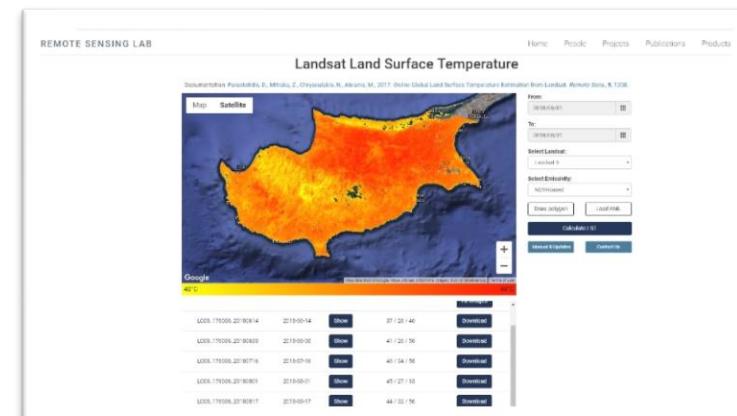
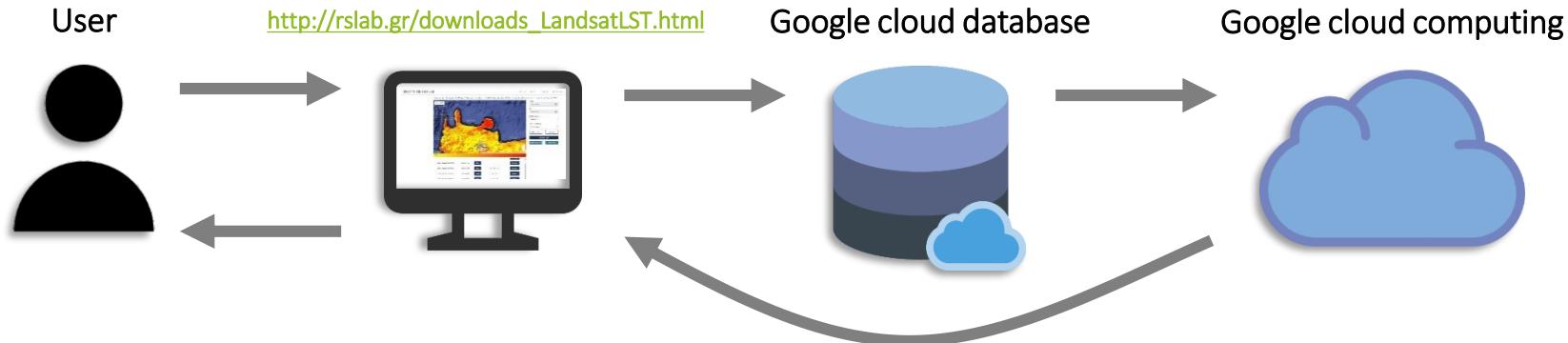


Surface Temperature Monitoring

Downscaling Methodology

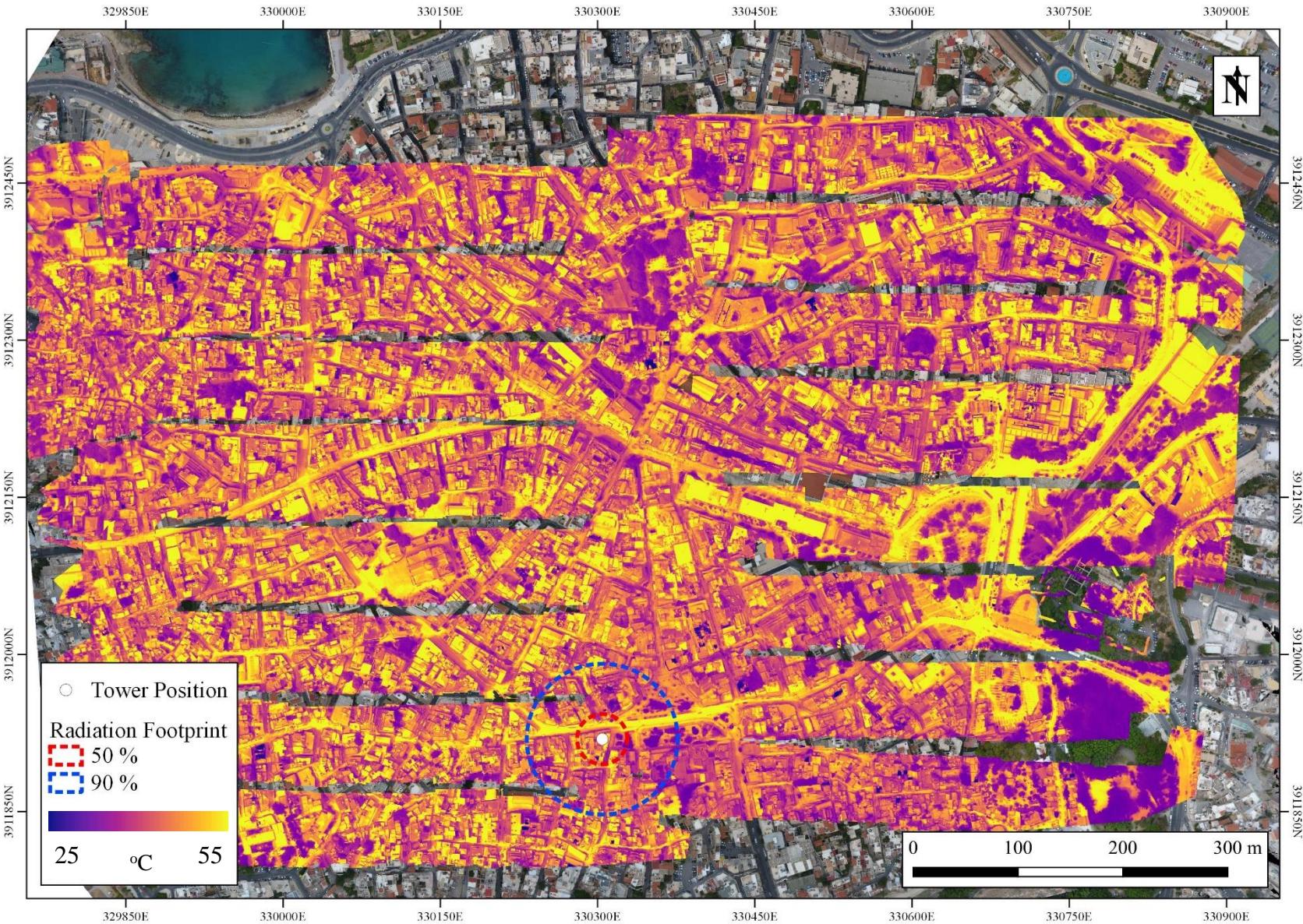


Global LST tool



Parastatidis, et al. 2017. Online Global Land Surface Temperature Estimation from Landsat.

Surface Temperature Monitoring

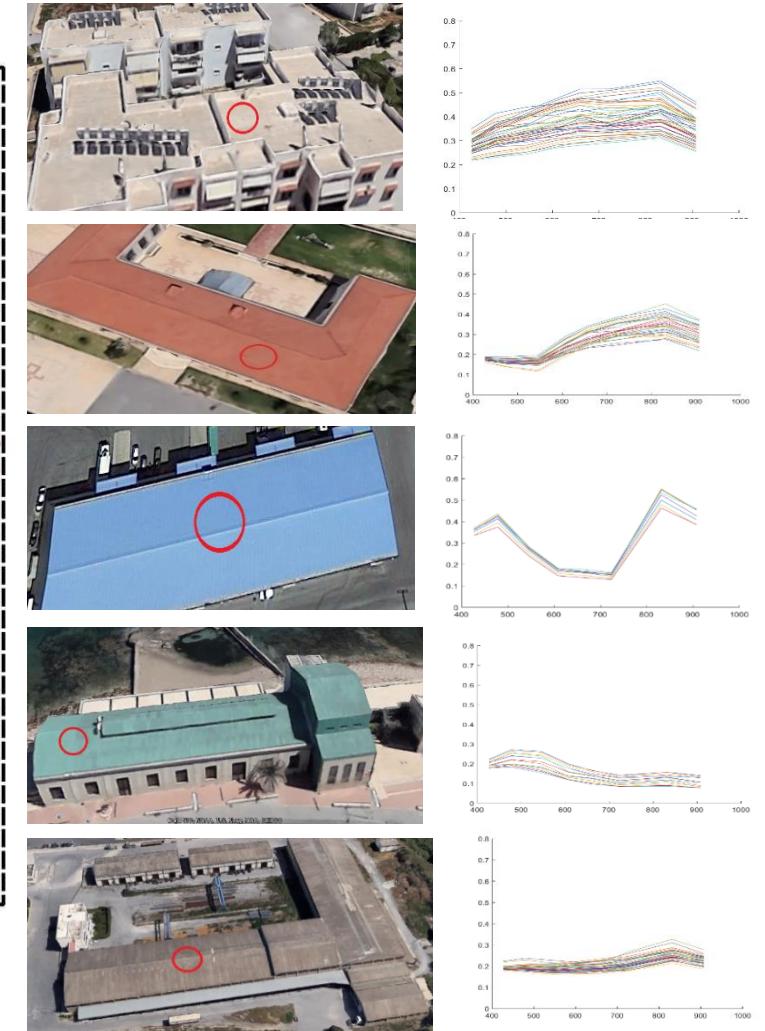
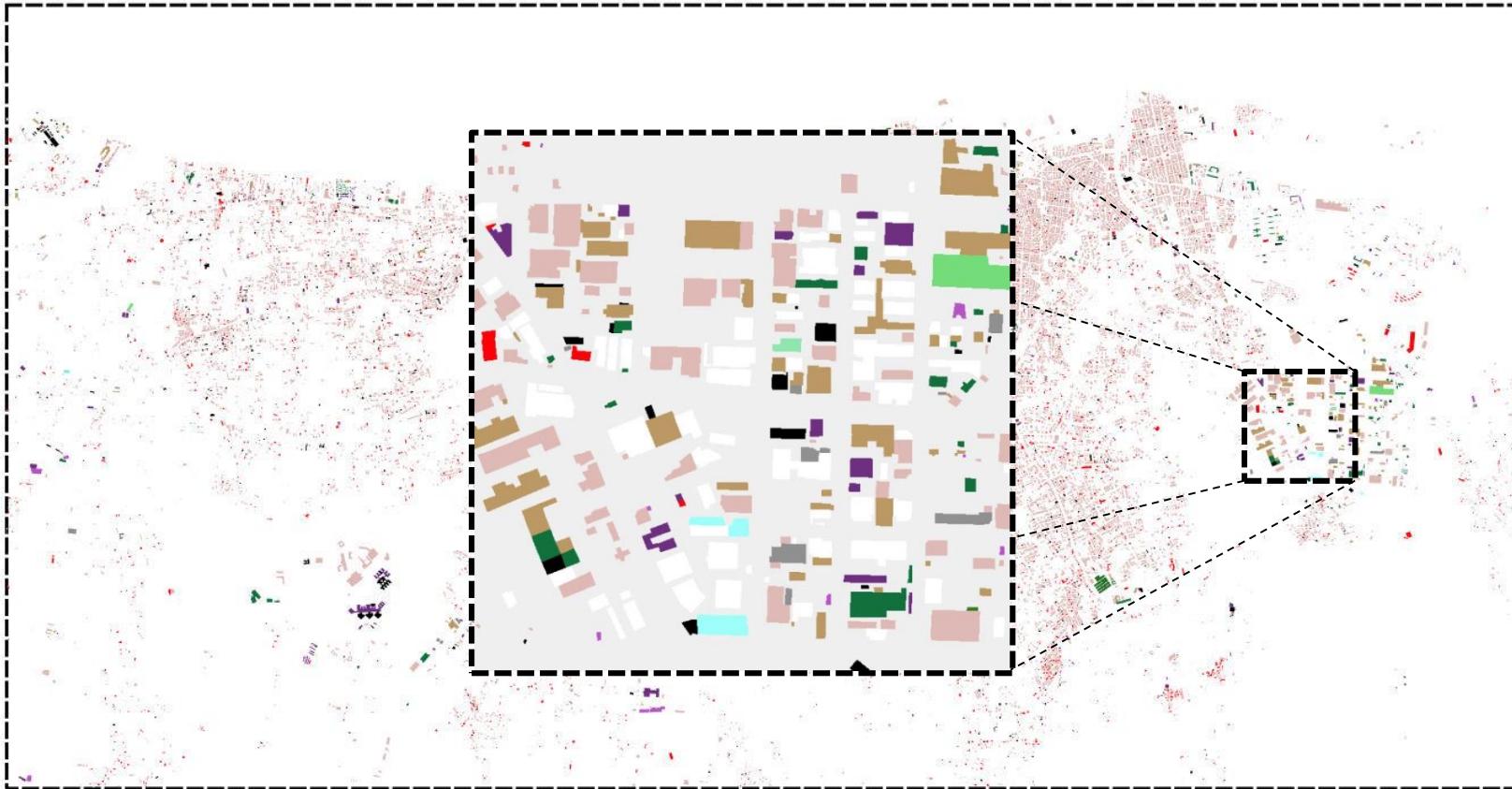


Heraklion
26/07 14:30



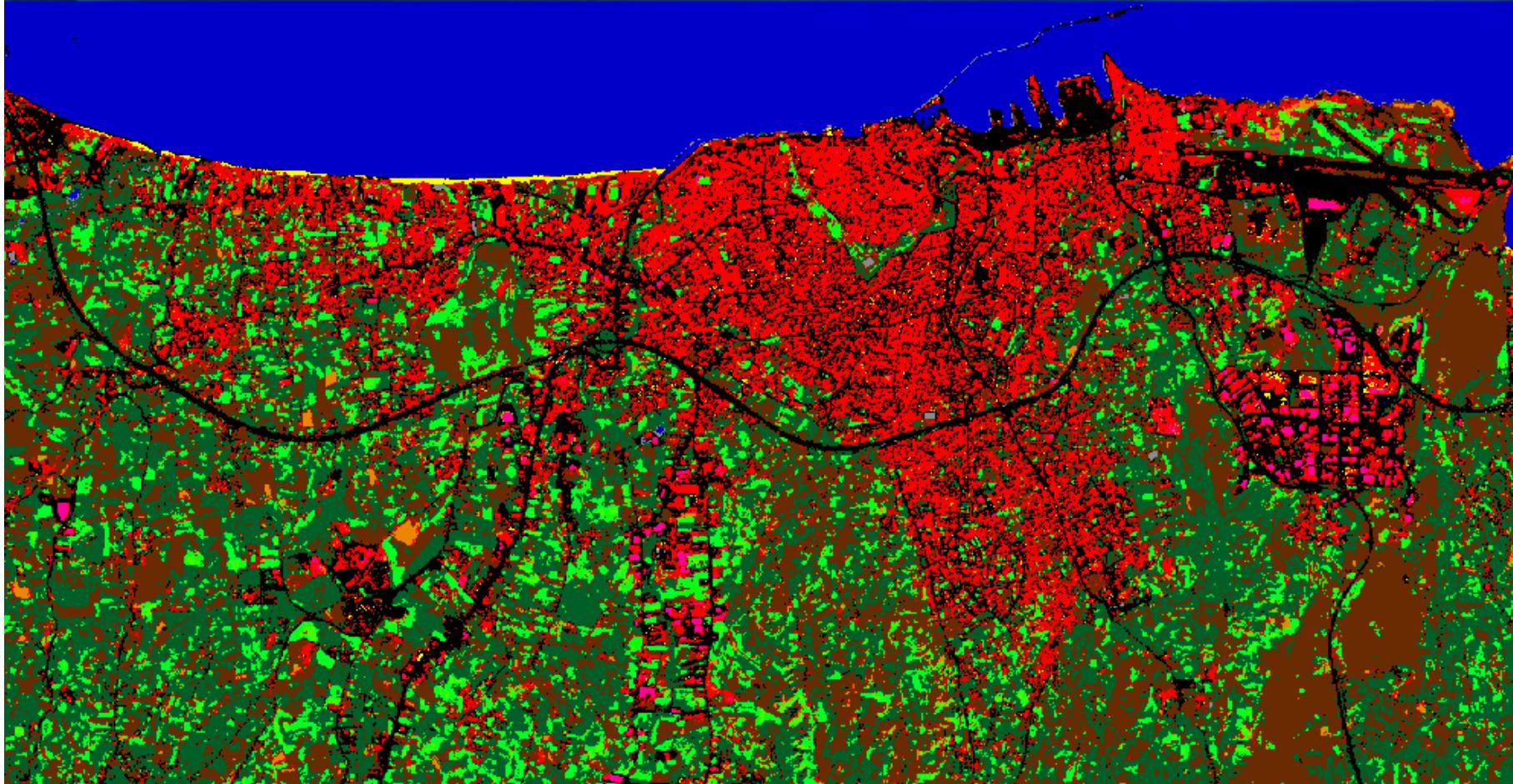
Surface Fabric

Material Recognition with extended Support Vector Machines Algorithm:
Application on WorldView-2



Surface Fabric

Material Recognition with extended Support Vector Machines Algorithm:
Application on Sentinel-2

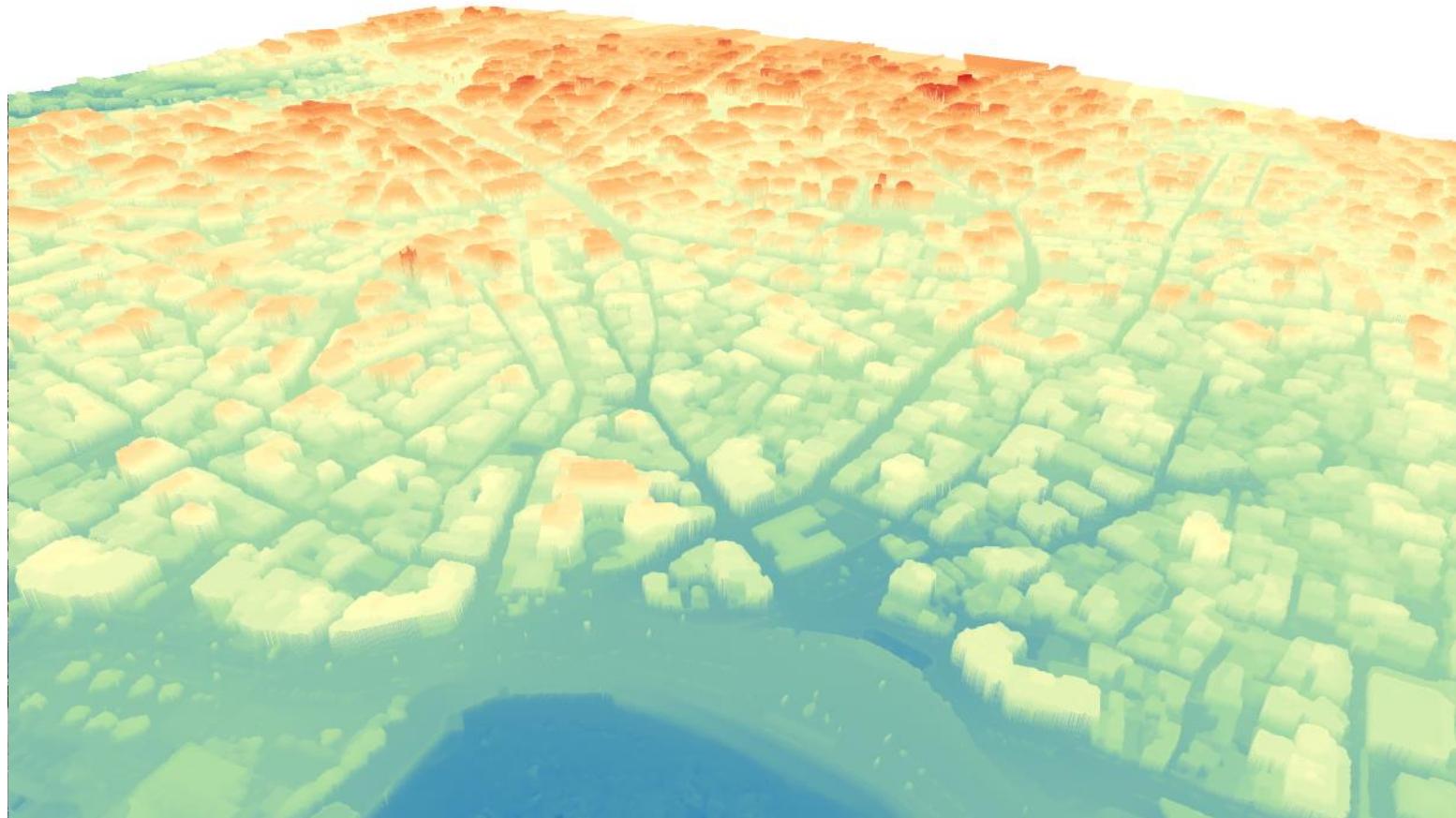


- Tiles
- Concrete
- Industrial Mat.
- Asphalt
- Caoutchouc
- Grass
- Low Vegetation
- High Vegetation
- Sand
- Rocks
- Bare Soil



Surface Structure and Morphology

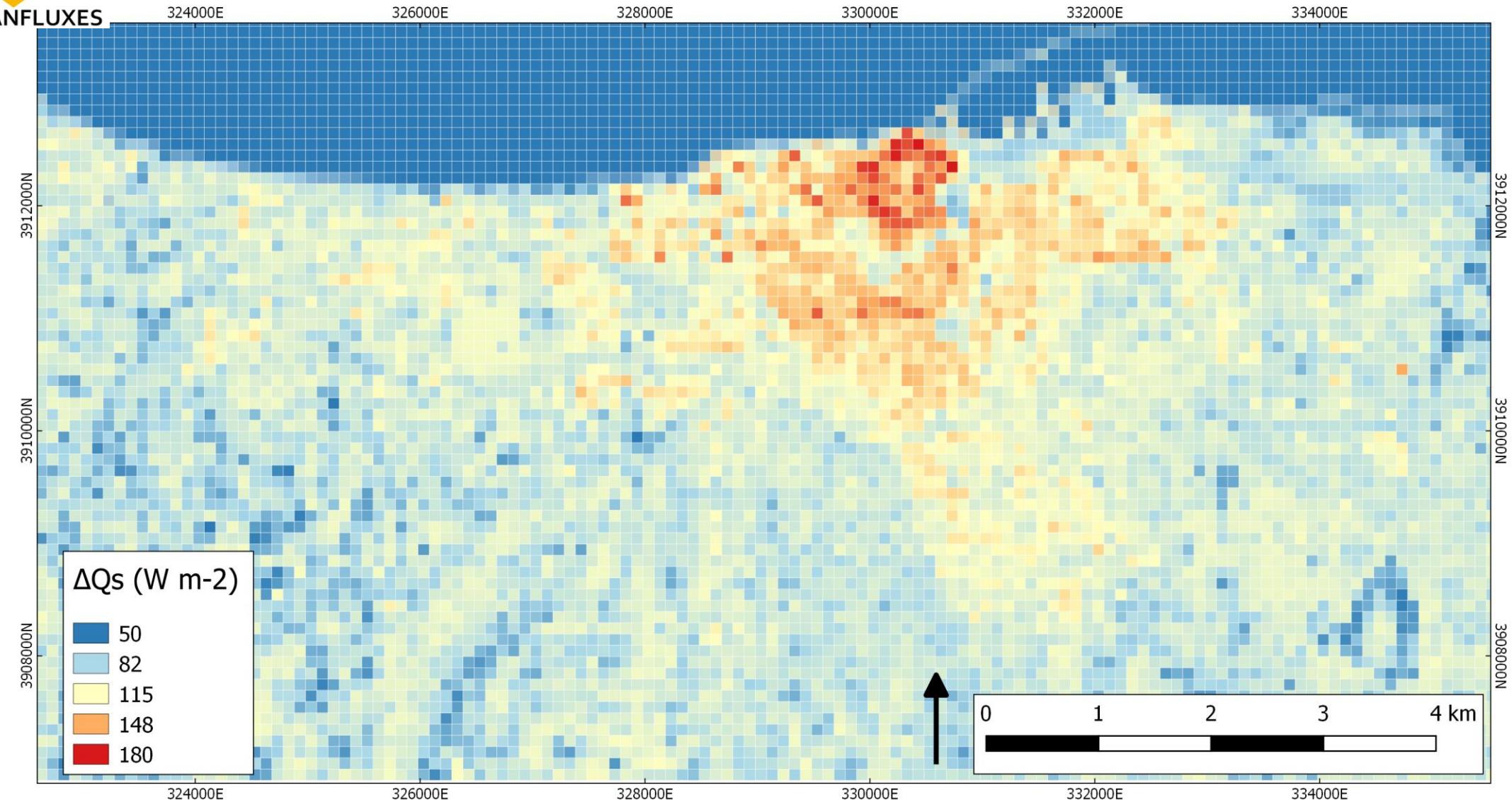
- › Relevant parameters: SVF, λ_p , λ_f , z_d & z_0 :





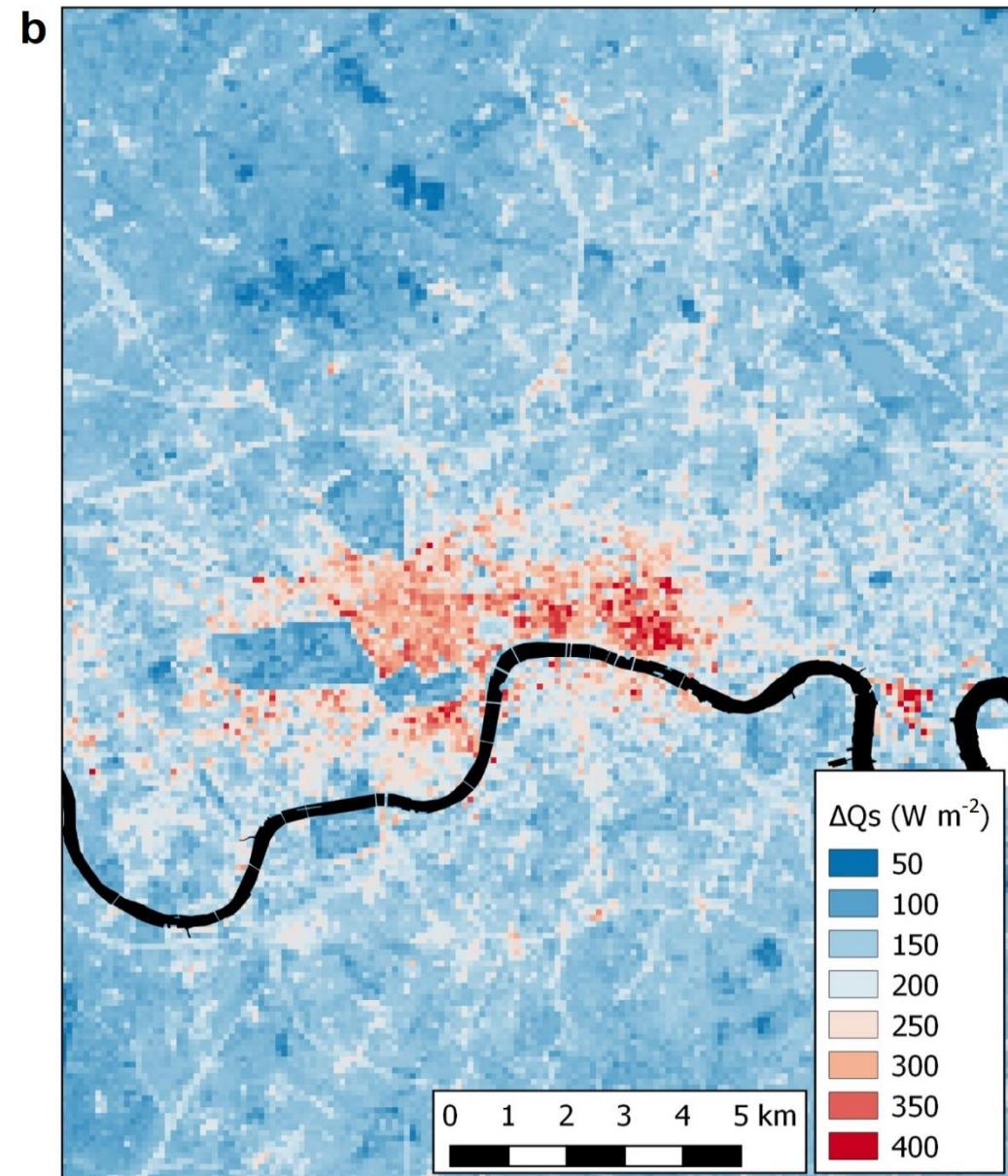
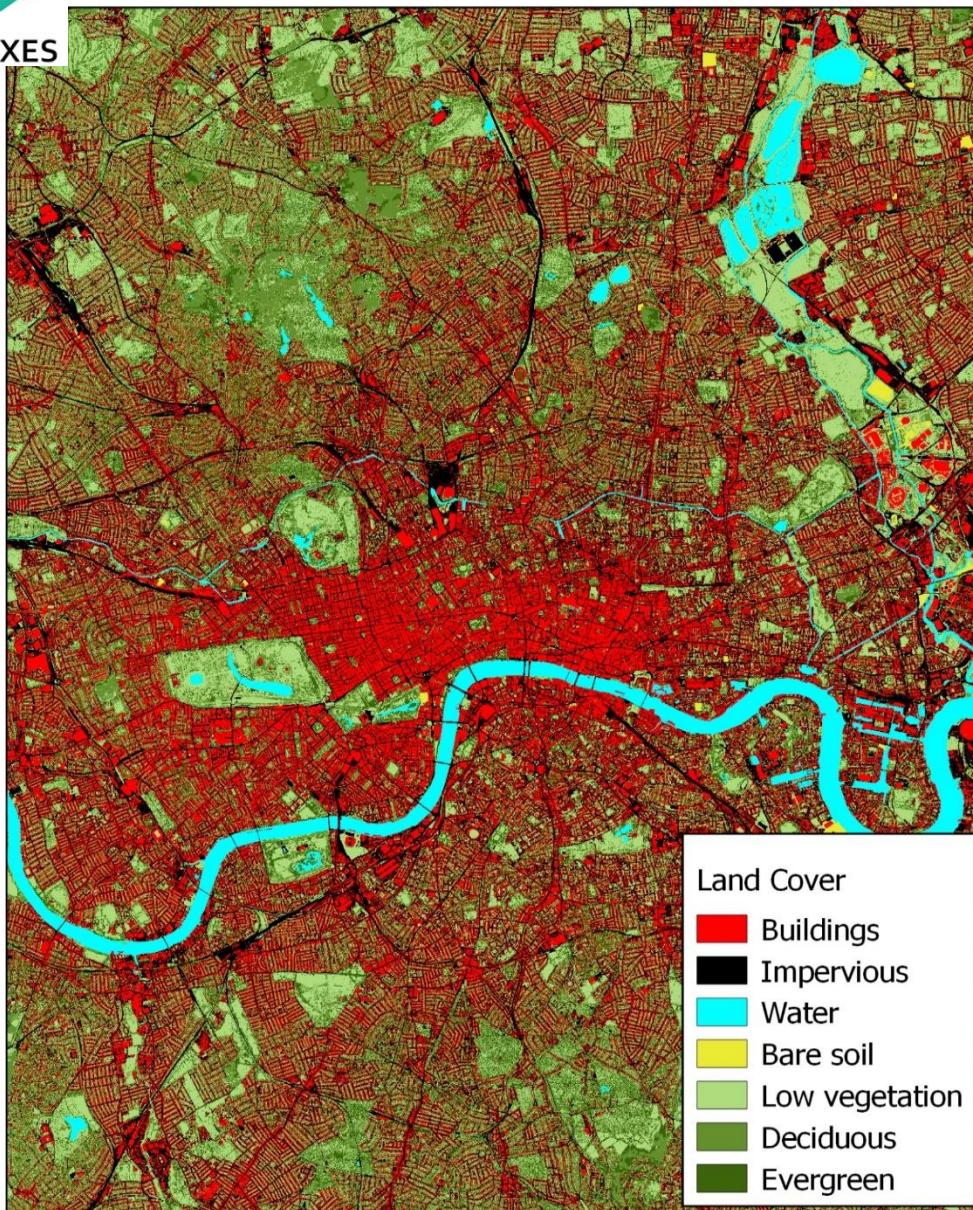
URBANFLUXES

Heat Storage Change (ΔQ_s)





Heat Storage Change (ΔQ_s)





URBANFLUXES Database

ⓘ urbanfluxes.eu/data/

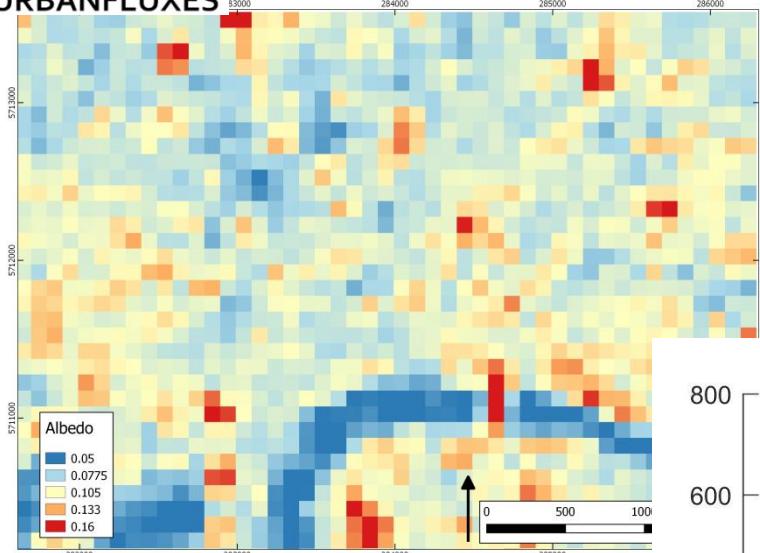
The available data, so far, are listed below. Click on a data title to have the data downloaded. You can use the search field to query specific data

Filter files ...

Title	Temporal Extent	Spatial Resolution	File Size
Heat storage 20151002_1059 (London)	2015-10-02 - 2015-10-02	100 m	139.94k
Heat storage 20150830_1116 (Basel)	2015-08-30 - 2015-08-30	100 m	138.08k
Net All-Wave Radiation flux (London)	2013-08-06 - 2017-04-29	100 m	2.04M
Landsat local solar zenith angle (London)	2010-01-01 - 2016-08-31	100 m	23.04M
Heat storage 20160713_1054 (Heraklion)	2016-07-13 - 2016-07-13	100 m	26.68k
Downscaled Surface Temperature (Heraklion)	2016-01-01 - 2016-12-31	100 m	5.08M
Downscaled Surface Temperature (Basel)	2016-01-01 - 2016-12-31	100 m	18.56M
Latent heat flux (London)	2016-01-01 - 2016-12-31	100 m	20.25M
Sensible heat flux (London)	2016-01-01 - 2016-12-31	100 m	38.05M
Total Wall Area (Heraklion)	2015-01-01 - 2015-12-31	100 m	21.54k
Sentinel-2 Normalized Difference Vegetation Index (Heraklion)	2015-01-01 - 2017-04-30	100 m	2.26M
Sentinel-2 Surface Reflectance (Heraklion)	2015-01-01 - 2017-04-30	100 m	10.56M
Land Cover Fractions (London)	2015-01-01 - 2015-12-31	100 m	2.3M
Landsat Surface Reflectance (Basel)	2010-01-01 - 2016-08-31	100 m	129.56M
Buildings Anisotropic Morphometric Parameters (Basel)	2015-01-01 - 2015-12-31	100 m	26.29M
Sentinel-2 Normalized Difference Vegetation Index (Basel)	2015-01-01 - 2017-04-30	100 m	4.5M
Sentinel-2 Surface Reflectance (Basel)	2015-01-01 - 2017-04-30	100 m	21.02M
Land Cover Fractions (Heraklion)	2015-01-01 - 2015-12-31	100 m	108.41k
Landsat Aerosol Optical Thickness (Heraklion)	2010-01-01 - 2016-08-31	100 m	1.97M
Sentinel Surface Albedo (Heraklion)	2016-01-03 - 2017-04-30	100 m	16.69M
Landsat Surface Albedo (Heraklion)	2016-03-07 - 2016-07-29	100 meters	113.56k
Landsat Land Surface Temperature (Basel)	2010-01-01 - 2016-08-31	100 m	18.31M
Landsat Leaf Area Index (Basel)	2010-01-01 - 2016-08-31	100 m	7.19M
Landsat local solar zenith angle (Basel)	2010-01-01 - 2016-08-31	100 m	7.69M
Landsat Normalized Difference Vegetation Index (Basel)	2010-01-01 - 2016-08-31	100 m	43.07M
Heat storage 2016 (Heraklion) - time series	2016-01-01 - 2016-12-31	100 m	5.94M



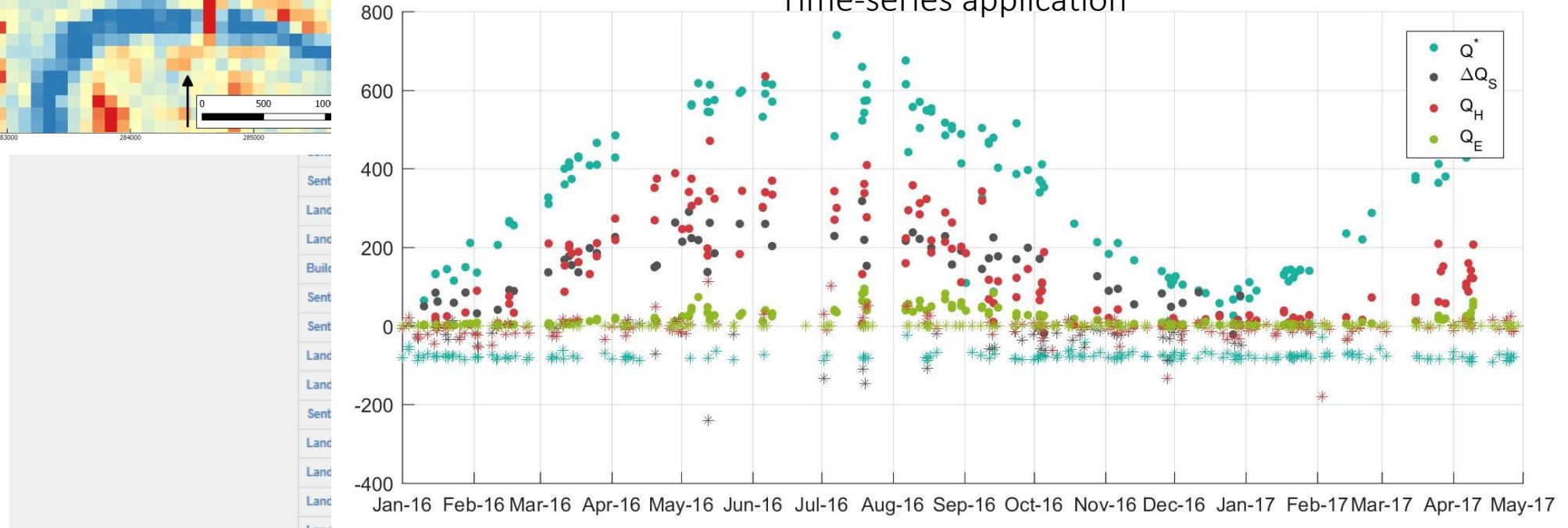
URBANFLUXES



so far, are listed below. Click on a data title to have the data downloaded. You can use the search field to query specific data

	Temporal Extent	Spatial Resolution	File Size
IS (London)	2015-10-02 - 2015-10-02	100 m	139.94k
IS (Basel)	2015-08-30 - 2015-08-30	100 m	138.08k
(London)	2013-06-06 - 2017-04-29	100 m	2.04M
Single (London)	2010-01-01 - 2016-08-31	100 m	23.04M

Time-series application



Landsat Normalized Difference Vegetation Index (Basel)

2010-01-01 - 2016-08-31

100 m

43.07M

Heat storage 2016 (Heraklion) - time series

2016-01-01 - 2016-12-31

100 m

5.94M



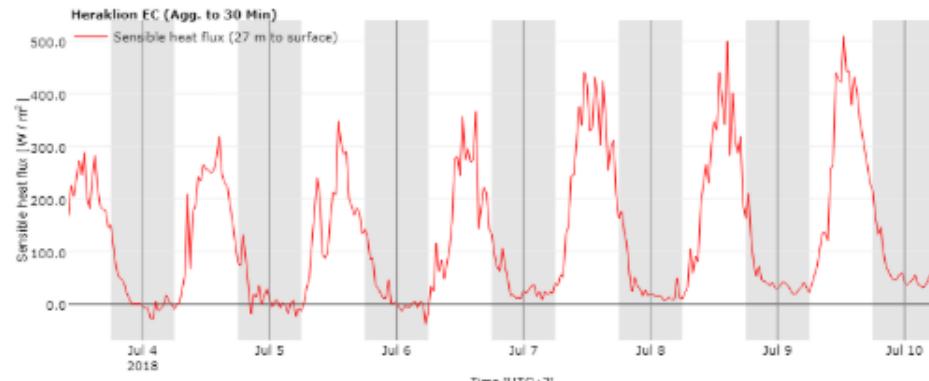
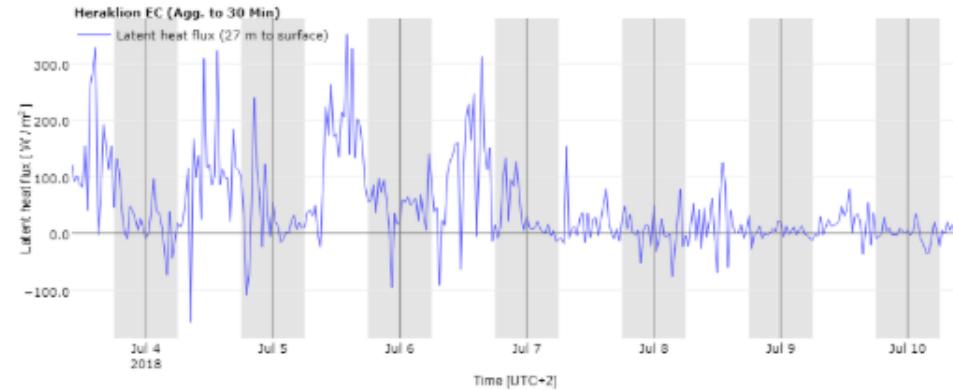
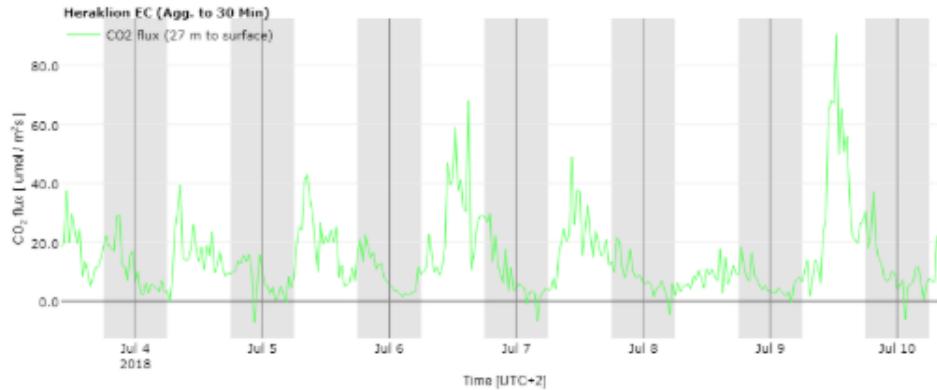
URBANFLUXES Database



rslab.gr

All Temperature Wind and air pressure Radiation **Fluxes**
Day Week Month

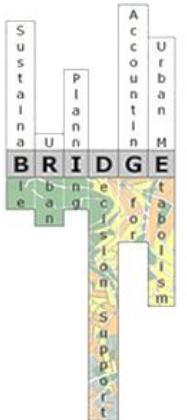
Username: Password: Sign In User Key: Sign In



http://rslab.gr/heraklion_eddy.html

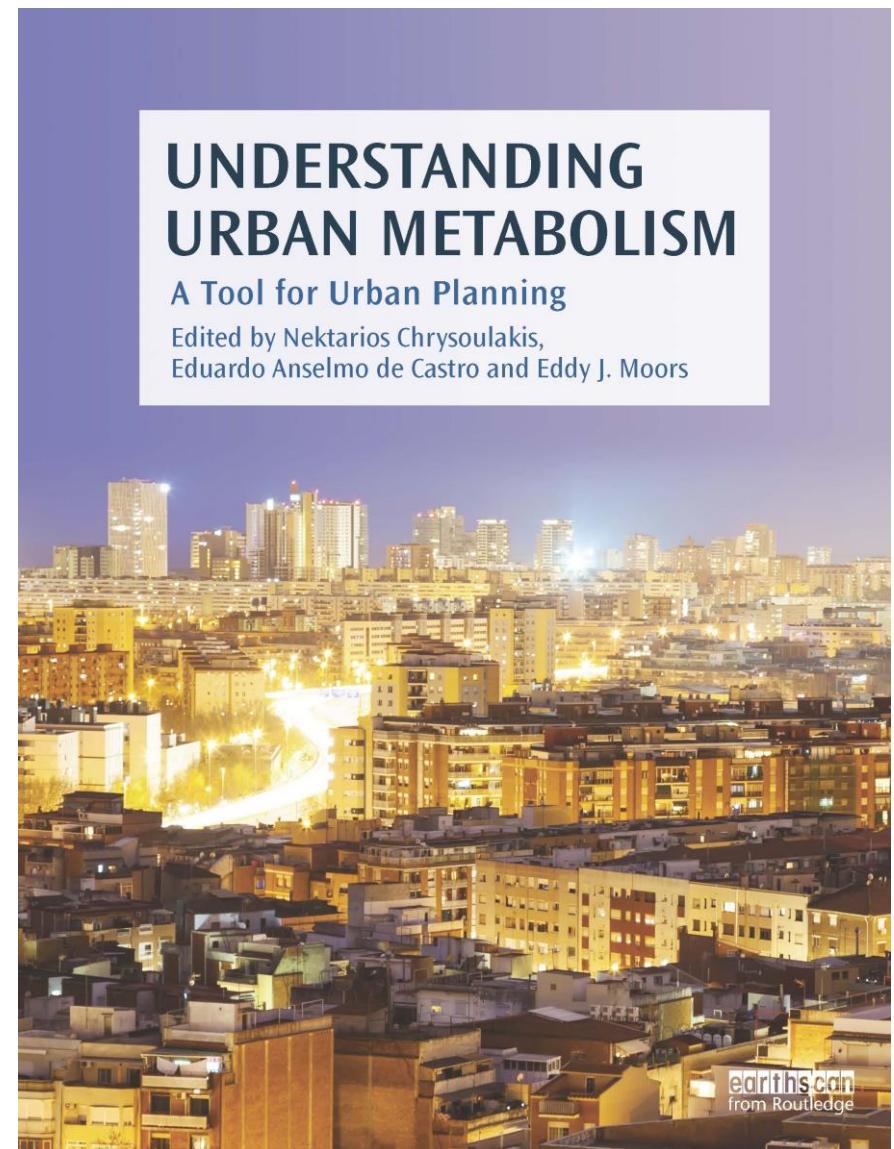
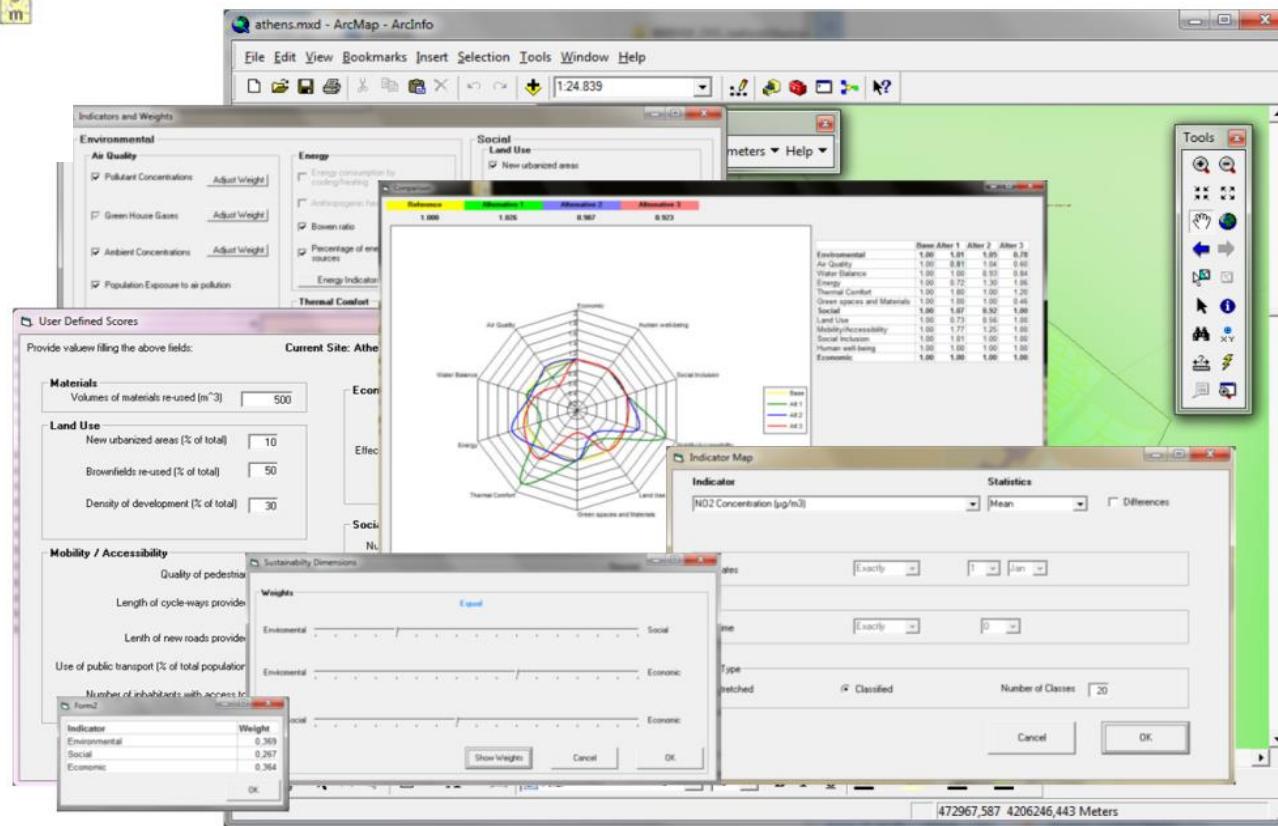
Urban Metabolism Approach

Lessons learned from FP7 BRIDGE project



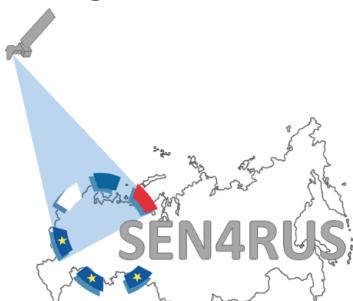


Urban Metabolism

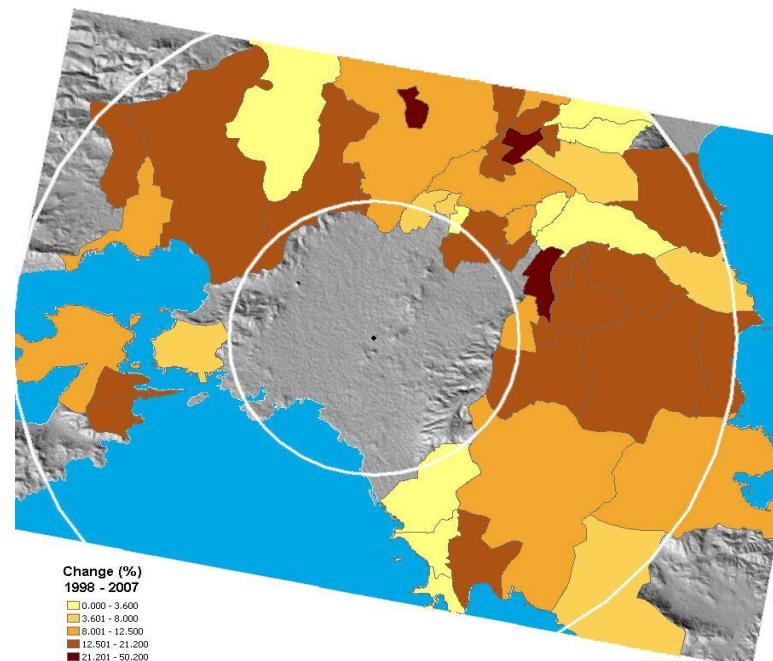
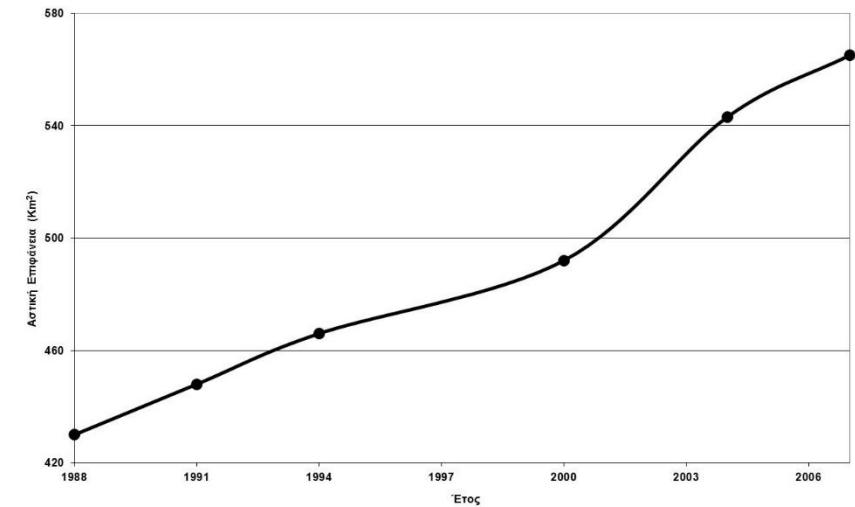
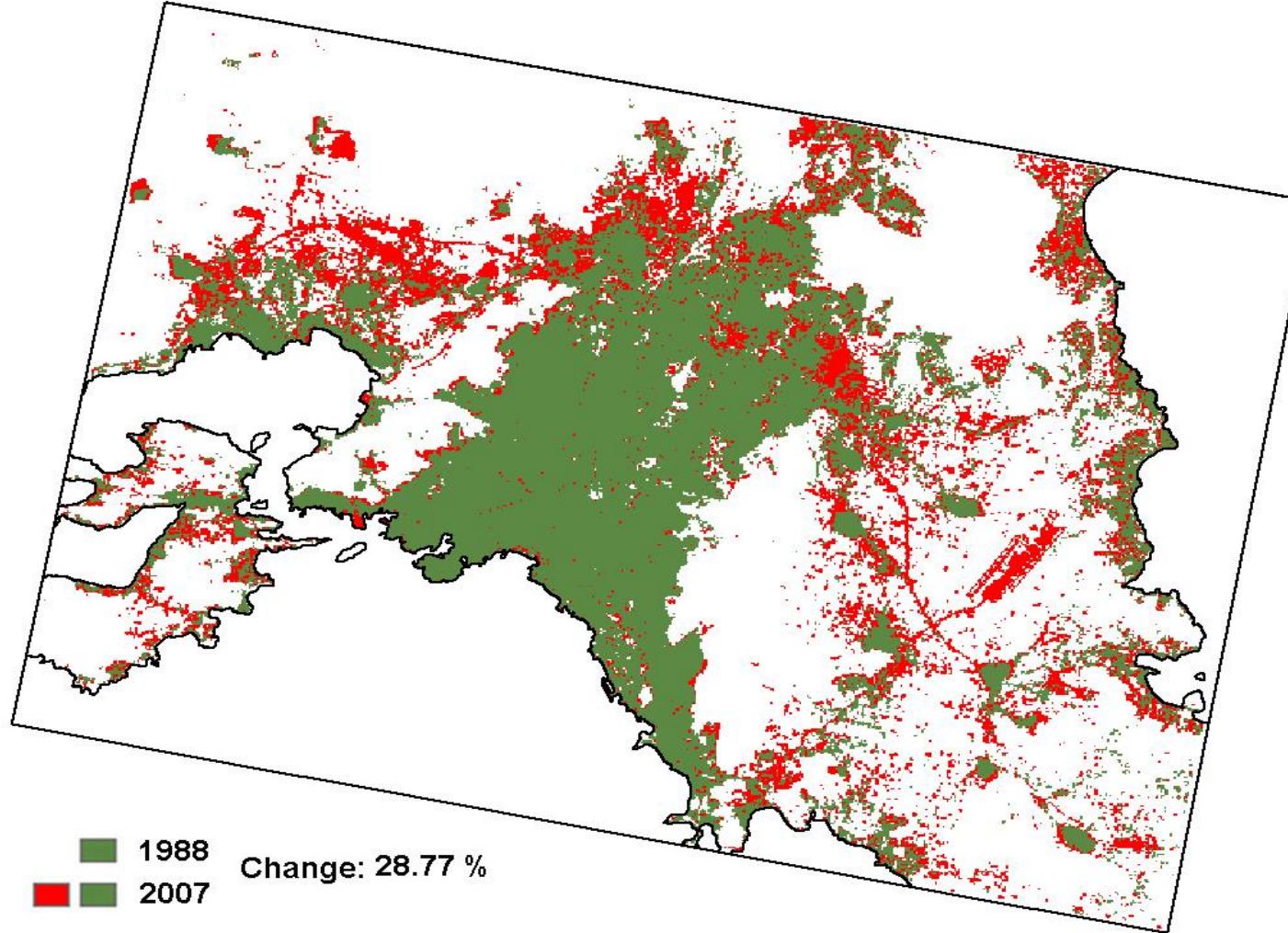
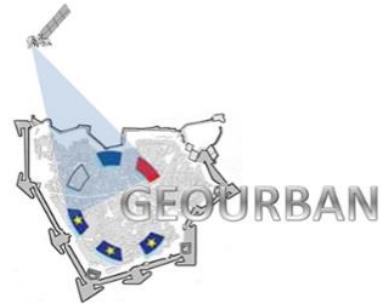


Tools and Indicators for sustainable Urban Planning

Lessons learned from GEOURBAN & SEN4RUS projects



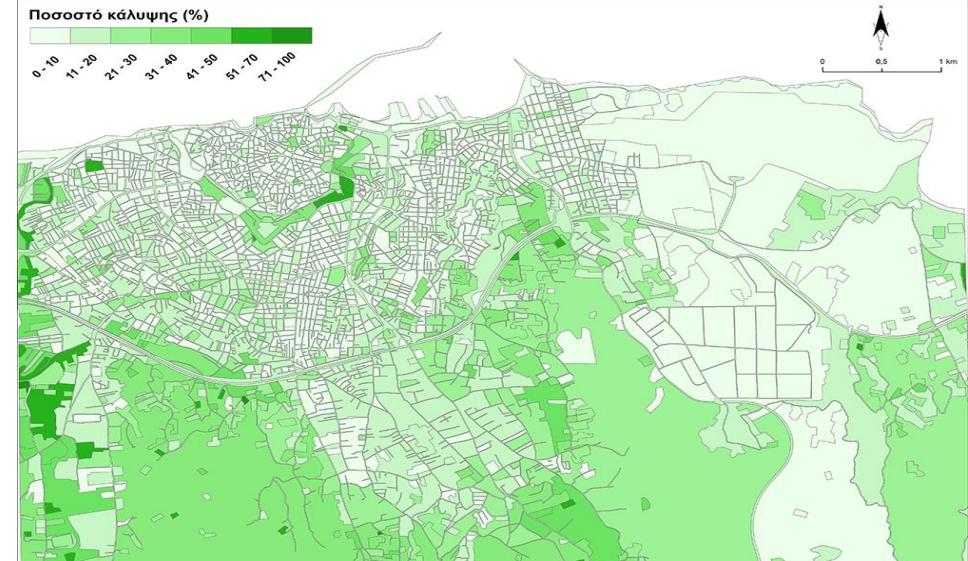
Urban Planning

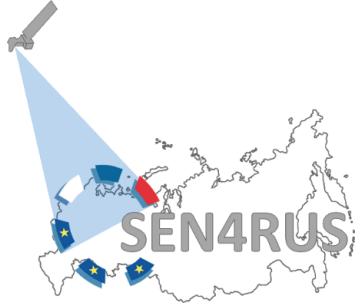




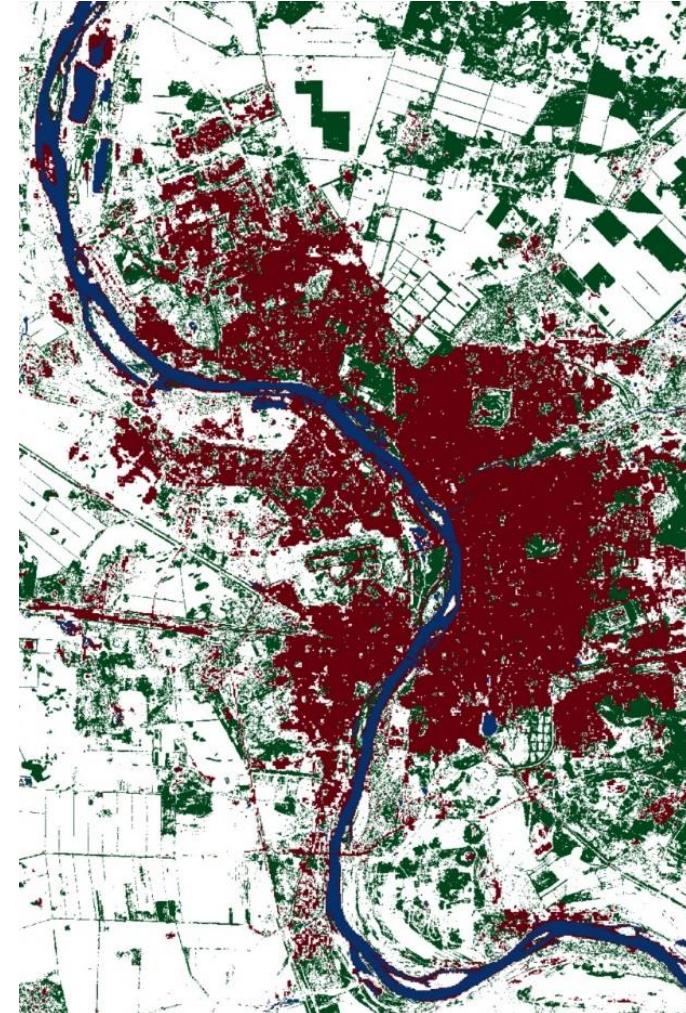
Urban Planning

Categories of Indicators		Indicators
Urban Surface Structure	Density indicators	Built-up density
		Building density
		Open Space Density
	Area/Edge indicators	Green Space Density
		Edge Density
	Ratio indicators	Imperviousness-Open space ratio
		Imperviousness-Green space ratio
Urban Surface Type		Class Richness Density
		Ecological Effectiveness Ratio
		Imperviousness
		Fractional Land Cover
Urban Sprawl		Surface Albedo
		Surface Emissivity
Urban Environmental Quality		Urban Fringe
		Change Detection
Vulnerability to hazards		Surface Urban Heat Island
		Aerosol Optical Thickness
Socioeconomics		Distance to critical services
		Exposure to PM

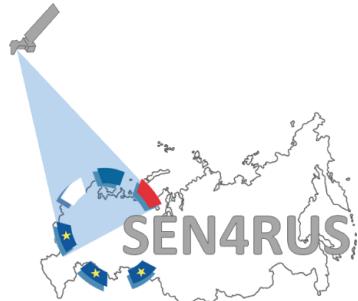




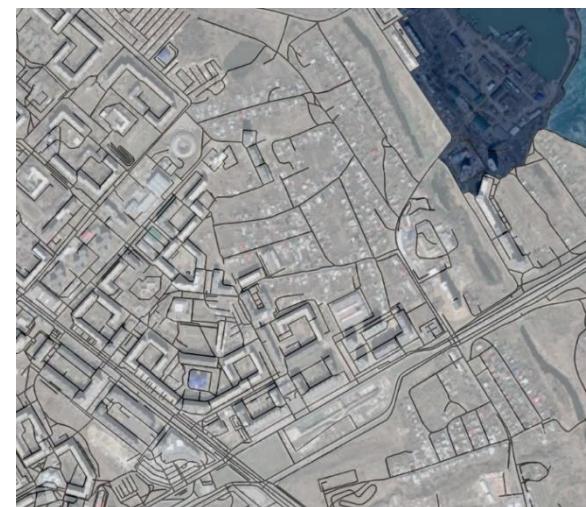
Urban Planning



Built-up
Vegetation
Water



Urban Planning



Built-Up Density

0.0 - 10.0
10.0 - 20.0
20.0 - 30.0
30.0 - 40.0
40.0 - 50.0
50.0 - 60.0
60.0 - 70.0
70.0 - 80.0
80.0 - 90.0
90.0 - 100.0

Vegetation Density

0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100

Water Density

0 - 2
2 - 4
4 - 5
5 - 7
7 - 9
9 - 11
11 - 12
12 - 14
14 - 16
16 - 18

Potential applications and future perspectives

Nature Based Solutions Monitoring

Environmental

Impact

- › Water runoff regulation - Flood protection
- › Urban temperature regulation
- › Energy consumption reduction
- › Air quality improvement
- › Water quality improvement
- › CO₂ emission reduction
- › Improvement of the soil quality, stability and erosion
- › Biodiversity enhancement
- › Noise reduction

- › Health and quality of life
- › Recreation and environmental education
- › Social cohesion
- › Connectivity/mobility

Social

Building Scale



Green roofs



Vertical gardens

Local Scale



Urban Parks



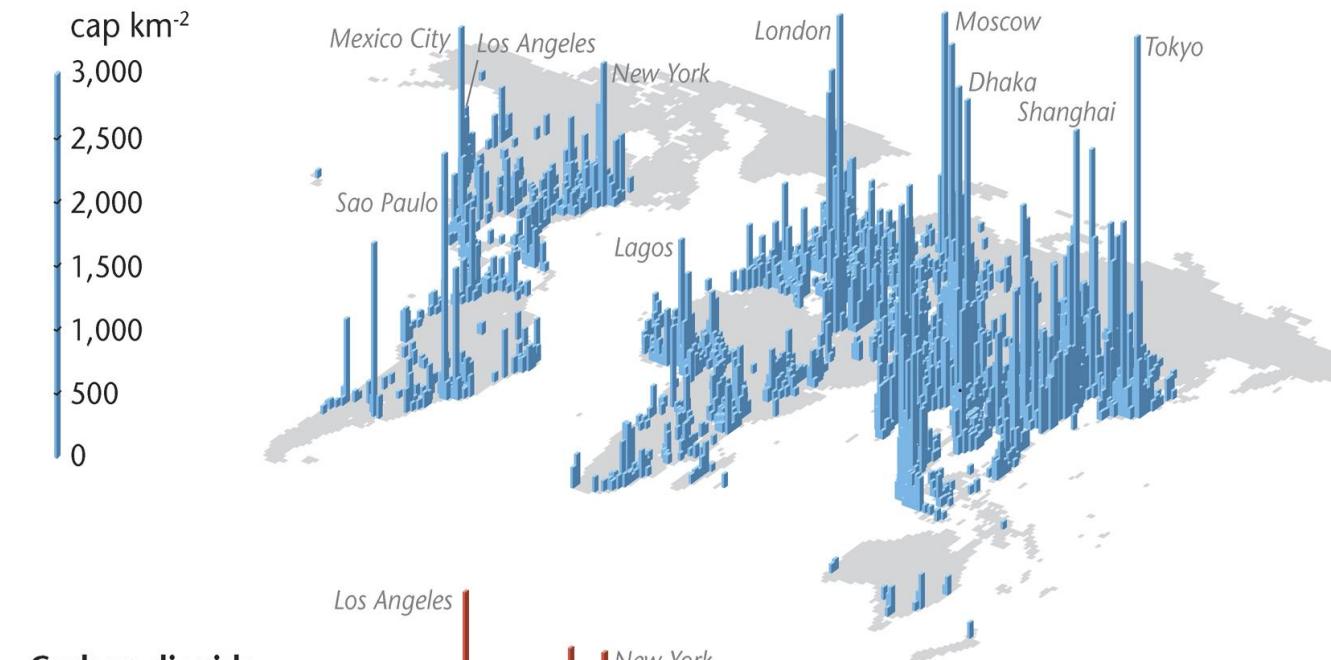
Urban Wetlands



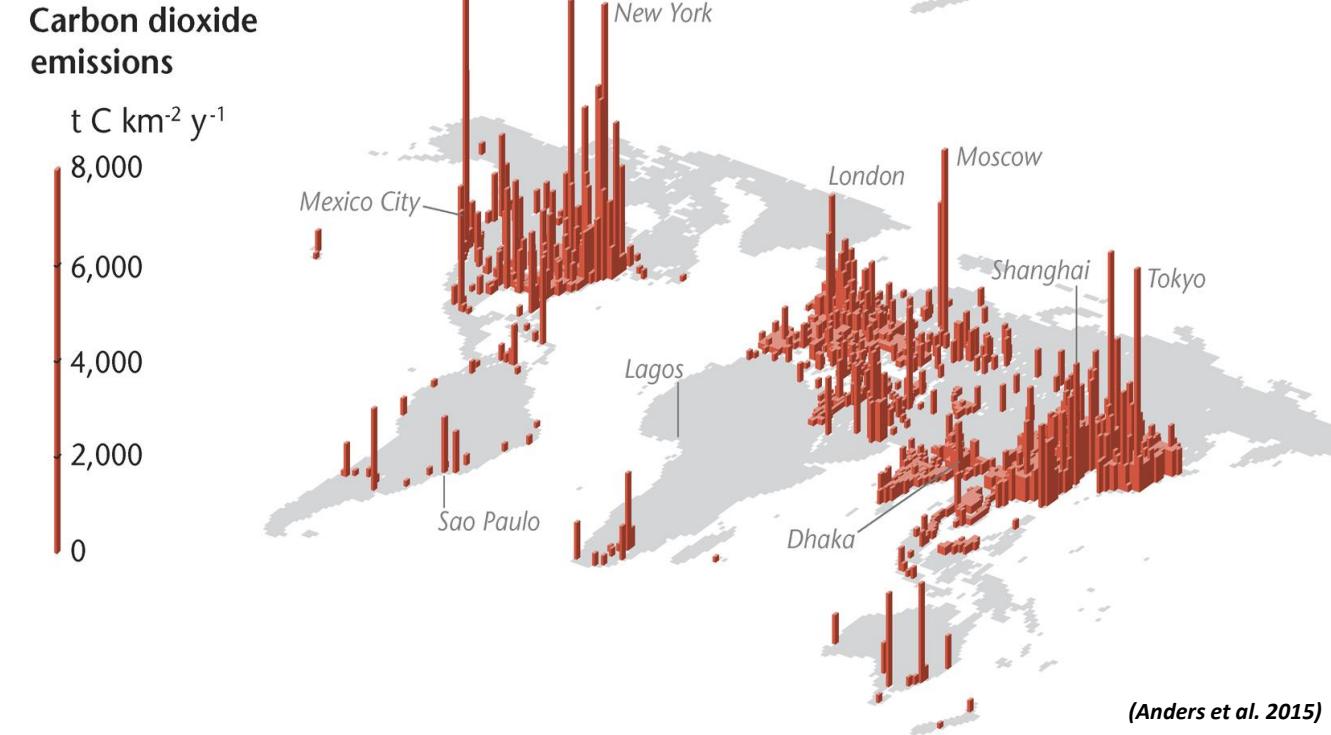
thinknature

<https://www.think-nature.eu/>

Population density



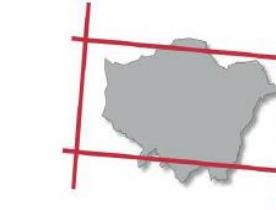
Carbon dioxide emissions



City CO₂ emissions from space

SCIAMACHY

$30 \times 60 \text{ km}^2$



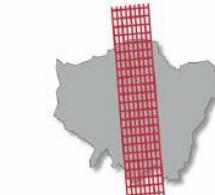
GOSAT

10 km



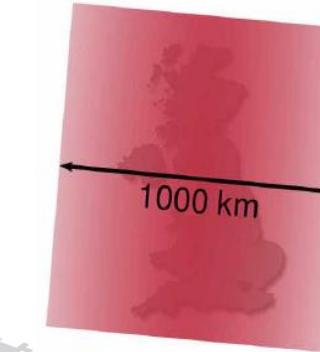
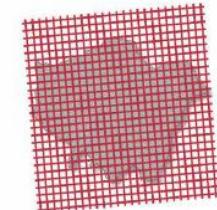
OCO-2

$2.3 \times 1.3 \text{ km}^2$



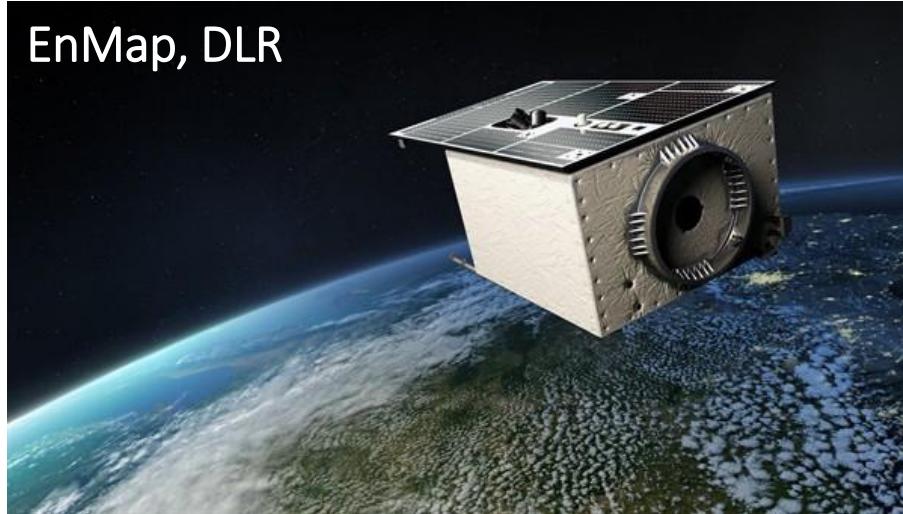
CarbonSat

$2 \times 3 \text{ km}^2$



Future perspectives

EnMap, DLR



HAPS



Use of forthcoming **Hyper-spectral missions** and

High Altitude Pseudo-Satellites (HAPS), for
enhanced:

- monitoring **urban environment**
- integrated **tools and methods**
- support **sustainable planning strategies**

Thank you!

Stavros Stagakis

FORTH/IACM

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