

EXPLOITING EARTH OBSERVATION DATA PRODUCTS FOR MAPPING LOCAL CLIMATE ZONES

Zina Mitraka^{1,3}, Nektarios Chrysoulakis¹, Jean-Philippe Gastellu-
Etchegorry², Fabio Del Frate³

¹ Foundation for Research
and Technology Hellas,
Greece

² Centre d'Etudes Spatiales
de la BIOSphère

³ University of Rome Tor
Vergata, Italy

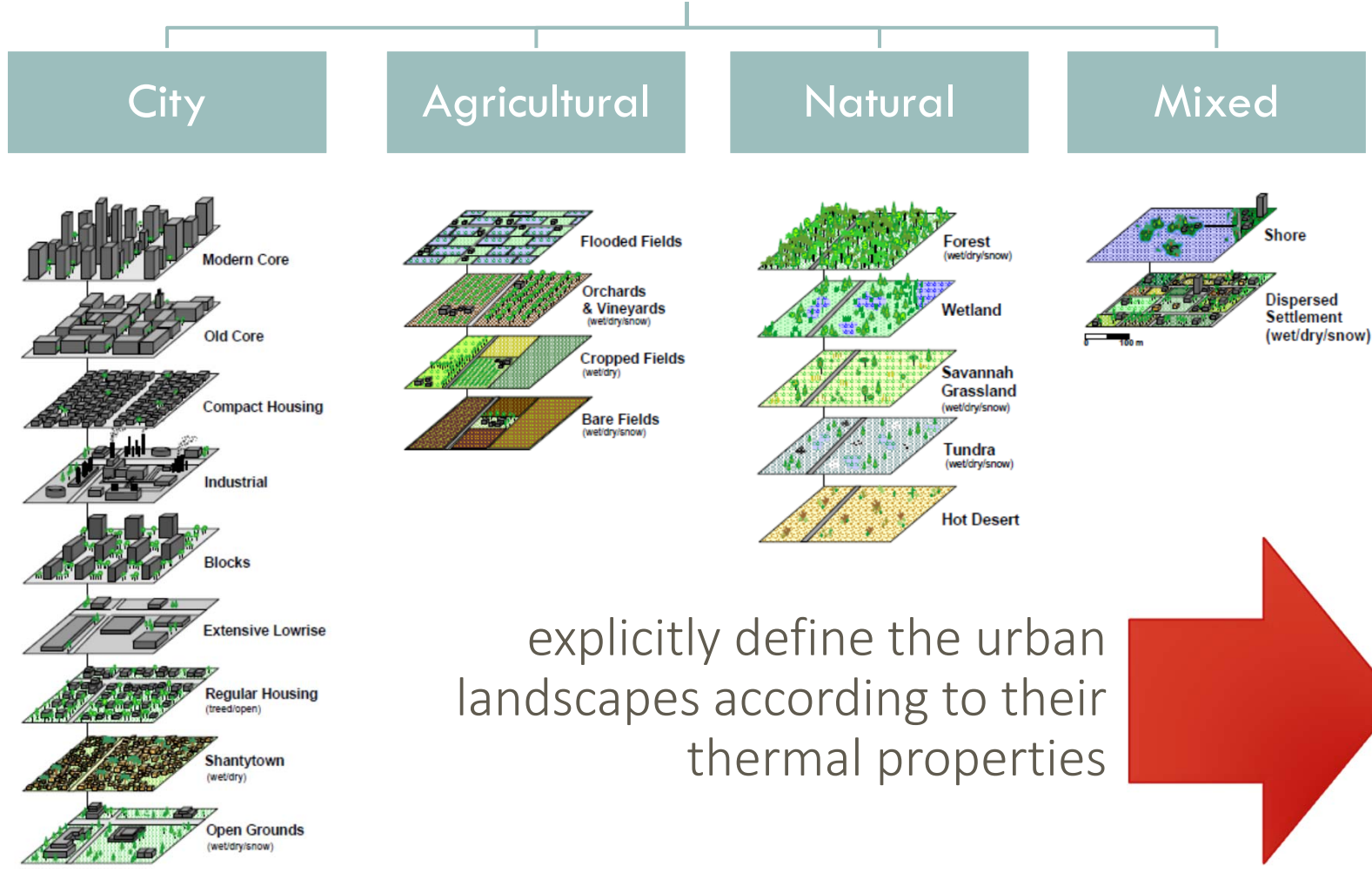


FORTH

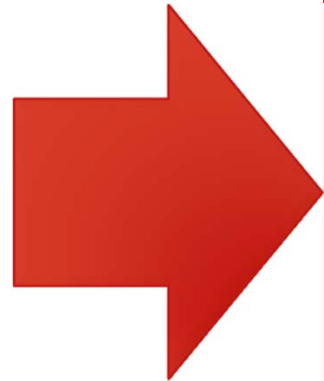


LOCAL CLIMATE ZONES (LCZ)

Urban Landscape



explicitly define the urban landscapes according to their thermal properties



LCZ OPEN LOW-RISE 6

DEFINITION

Form: Small buildings 1–3 stories tall. Buildings detached or attached in rows, often in grid pattern. Sky view from street level slightly reduced. Construction materials vary (wood, brick, stone, tile). Scattered trees and abundant plant cover. Low space heating/cooling demand. Low traffic flow. **Function:** Residential (single or multi-unit housing, low density terrace/row housing); commercial (small retail shops). **Location:** City (medium density); periphery (“suburbs”). Commuter towns. Rural towns. **Correspondence:** UCZ5 (Oke 2004); Do3 (Ellefsen 1990/91).

ILLUSTRATION



PROPERTY	VALUES
Sky view factor	0.6 – 0.9
Canyon aspect ratio	0.3 – 0.75
Mean building height	3 – 10 m
Terrain roughness class	5 – 6
Building surface fraction	20 – 40 %
Impervious surface fraction	20 – 50 %
Pervious surface fraction	30 – 60 %
Surface admittance	1,200 – 1,800 J m ⁻² s ^{-1/2} K ⁻¹
Surface albedo	0.12 – 0.25
Anthropogenic heat flux	< 25 W m ⁻²

THE EO4SEB PROJECT

Earth Observation for Surface Energy Balance

Objectives:

- › to exploit EO to derive parameters related to LCZ;
- › to investigate the potential of exploitation of recent (Landsat-8 and Sentinel-2) and upcoming (Sentinel 3) missions in SEB modelling;
- › to use derived EO products to parameterize DARTEB model.

Landier, L. et al. *Modeling Parameters and remote sensing acquisition of urban canopies*

Thursday 15:00 - 16:00, Poster Session 25



<http://www.eo4seb.gr>



Heraklion

THE URBANFLUXES PROJECT

Urban Anthropogenic heat flux from Earth Observation Satellites

Objective:

- › to investigate the potential of EO to retrieve anthropogenic heat flux, as a key component in the Urban Energy Budget

Chrysoulakis, N. et al. *A novel approach for anthropogenic heat flux estimation from space*

Friday 11:00 - 12:30, St-Exupéry Amphitheater



University of Reading



Heraklion



URBANFLUXES

<http://urbanfluxes.eu>

London

Basel



METHODOLOGY

EO Data/Products

Landsat

DEM, DSM

Building Footprints

LCZ parameters

Impervious surface cover

Pervious Surface Cover

Surface Albedo

Sky-view factor

Mean Building/Tree height

Building Density

Common Grid

LCZ post-processing

Average Filtering

Pixel classification

Moving window averaging

Zone determination

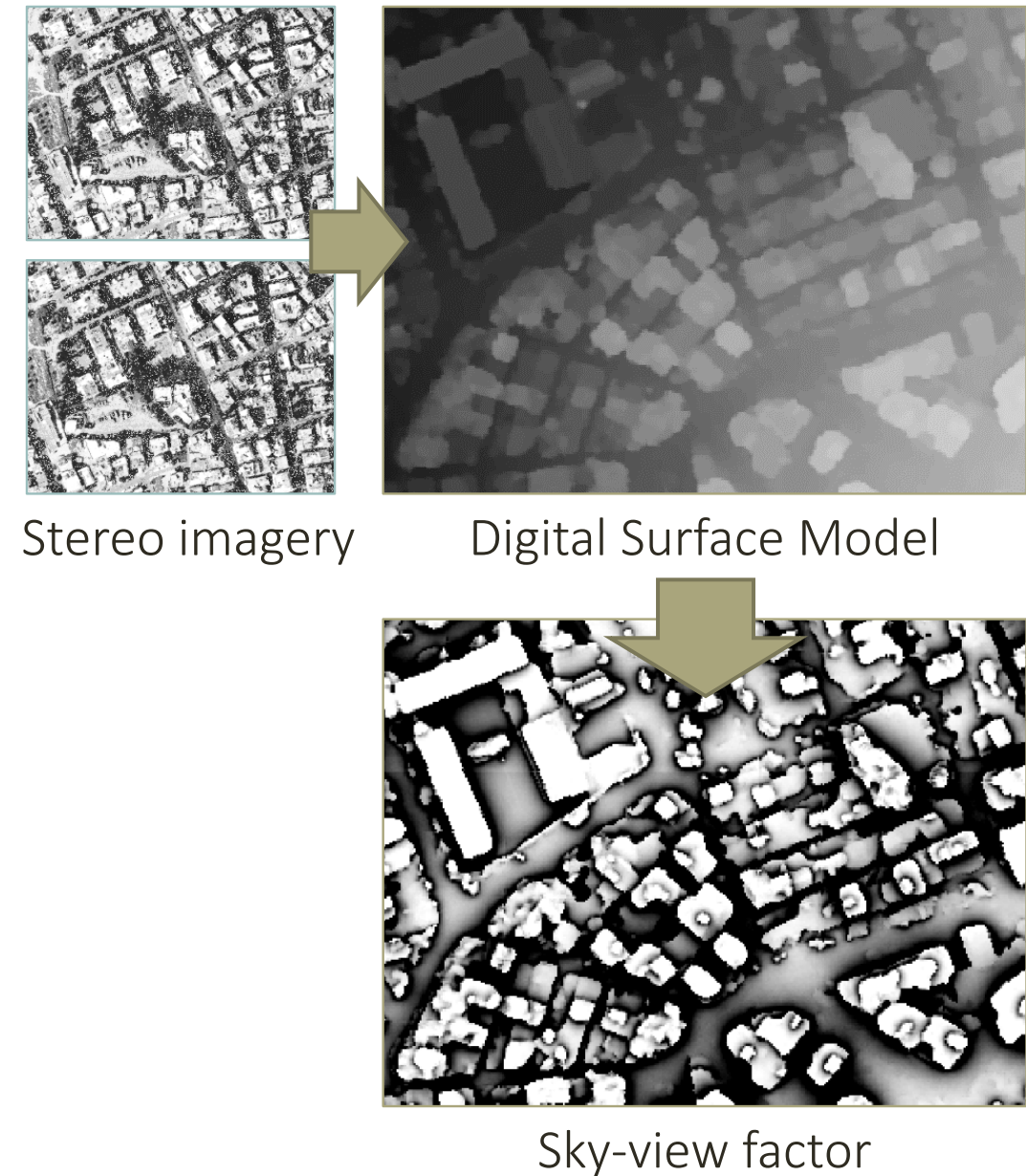
SKY-VIEW FACTOR

- › Sky-view factor
the fraction of sky hemisphere visible from ground level

Remote Sensing data

high resolution stereo imagery or LiDAR data

Lindberg, F. and Grimmond, C.S.B., 2010. Continuous sky view factor maps from high resolution urban digital elevation models. *Climate Research*, 42, 177 -183.



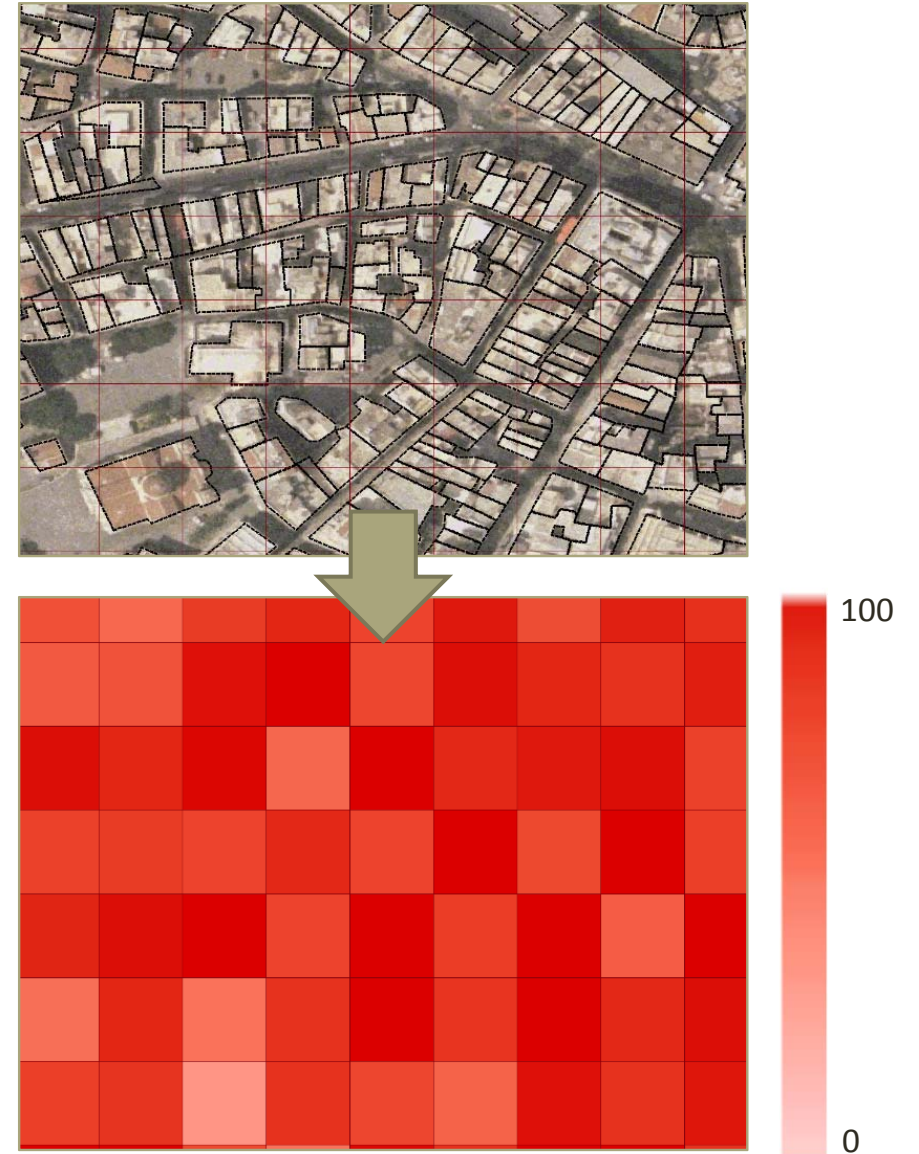
BUILDING DENSITY

- › Building Density
the proportion of ground surface with building cover

Remote Sensing data

high resolution optical imagery and/or LiDAR data
and/or SAR data

Esch, T., Thiel, M., Schenk, A., Roth, A., Müller, A. and Dech, S.,
2010. Delineating of urban footprints from TerraSAR-X data by
analyzing speckle characteristics and intensity information.
IEEE Transactions on Geoscience and Remote Sensing, 48, 905
- 916.



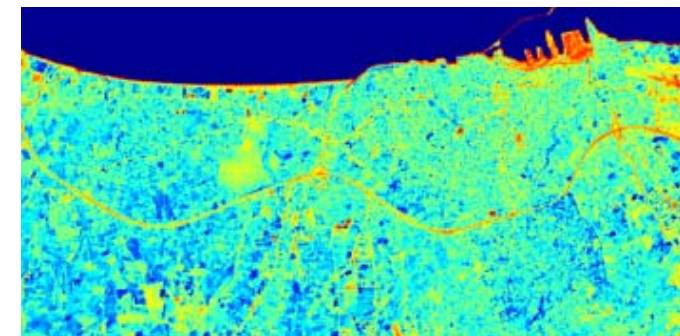
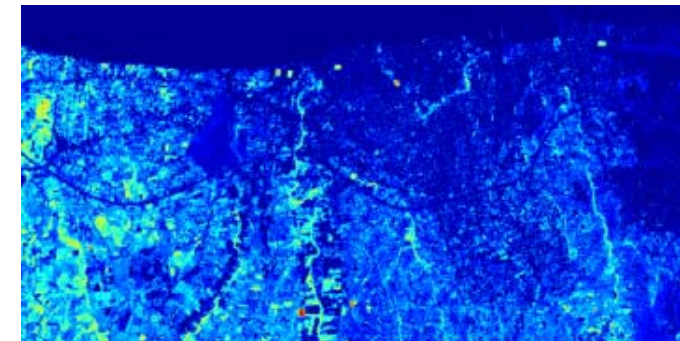
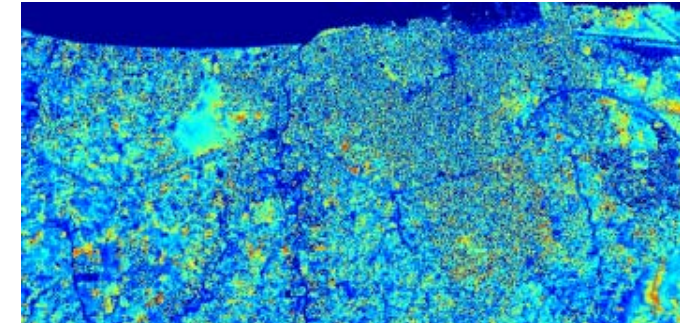
IMPERVIOUS, PERVIOUS SURFACE COVER

- › Impervious and Pervious Surface Fraction
the proportion of ground surface with impervious and
pervious cover

Remote Sensing data

high resolution multispectral/hyperspectral
imagery

Mitraka, Z., Chrysoulakis, N., Kamarianakis, Y., Partsinevelos, P. and Tsouchlaraki, A., 2012. Improving the estimation of urban surface emissivity based on sub-pixel classification of high resolution satellite imagery. *Remote Sensing of Environment*, 117, 125 - 134.

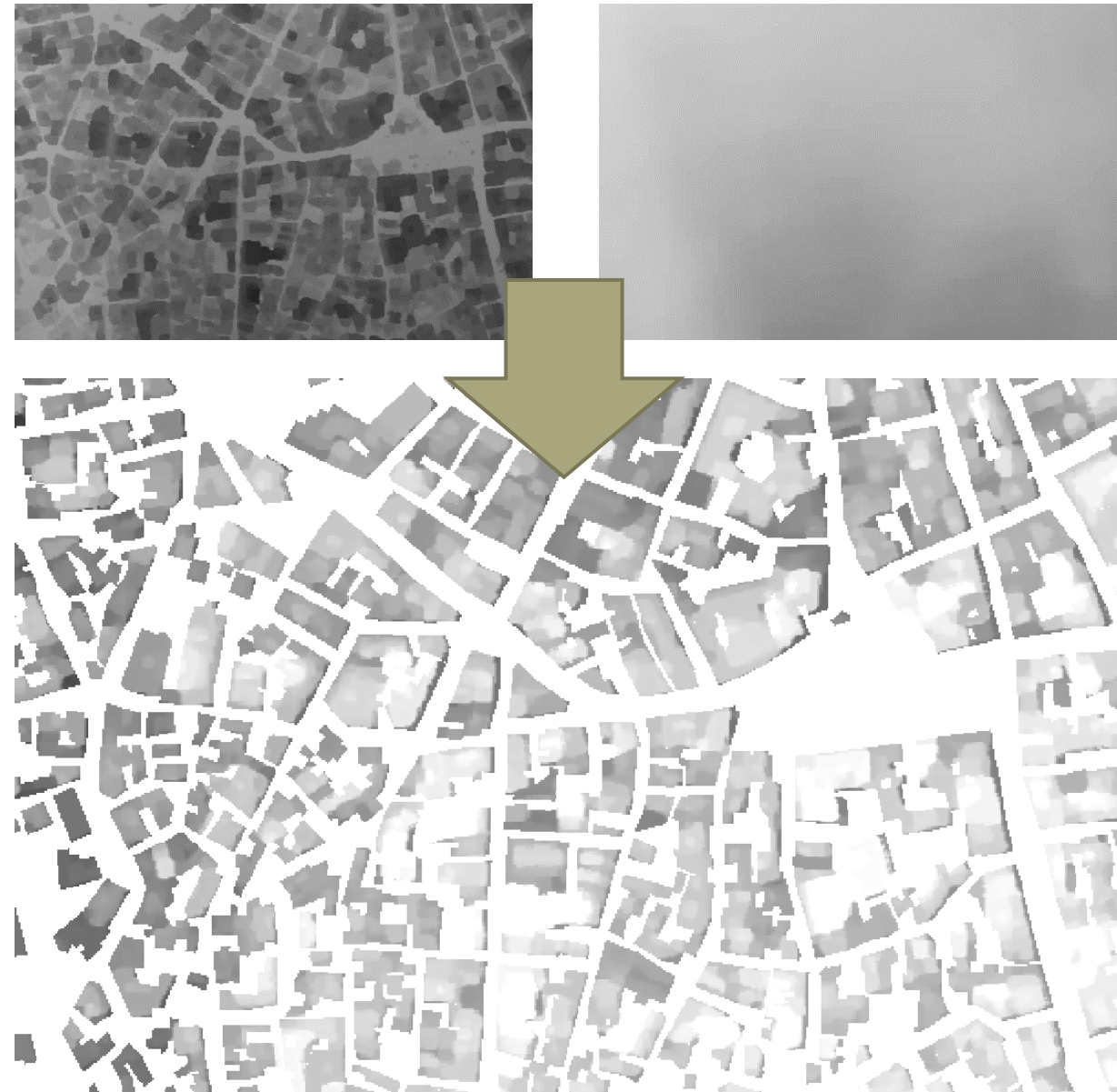


MEAN BUILDING, TREE HEIGHT

- › Mean Building/Tree Height
the spatial average of building heights in an area of interest

Remote Sensing data

high resolution stereo imagery or
LiDAR data or SAR data



SURFACE ALBEDO

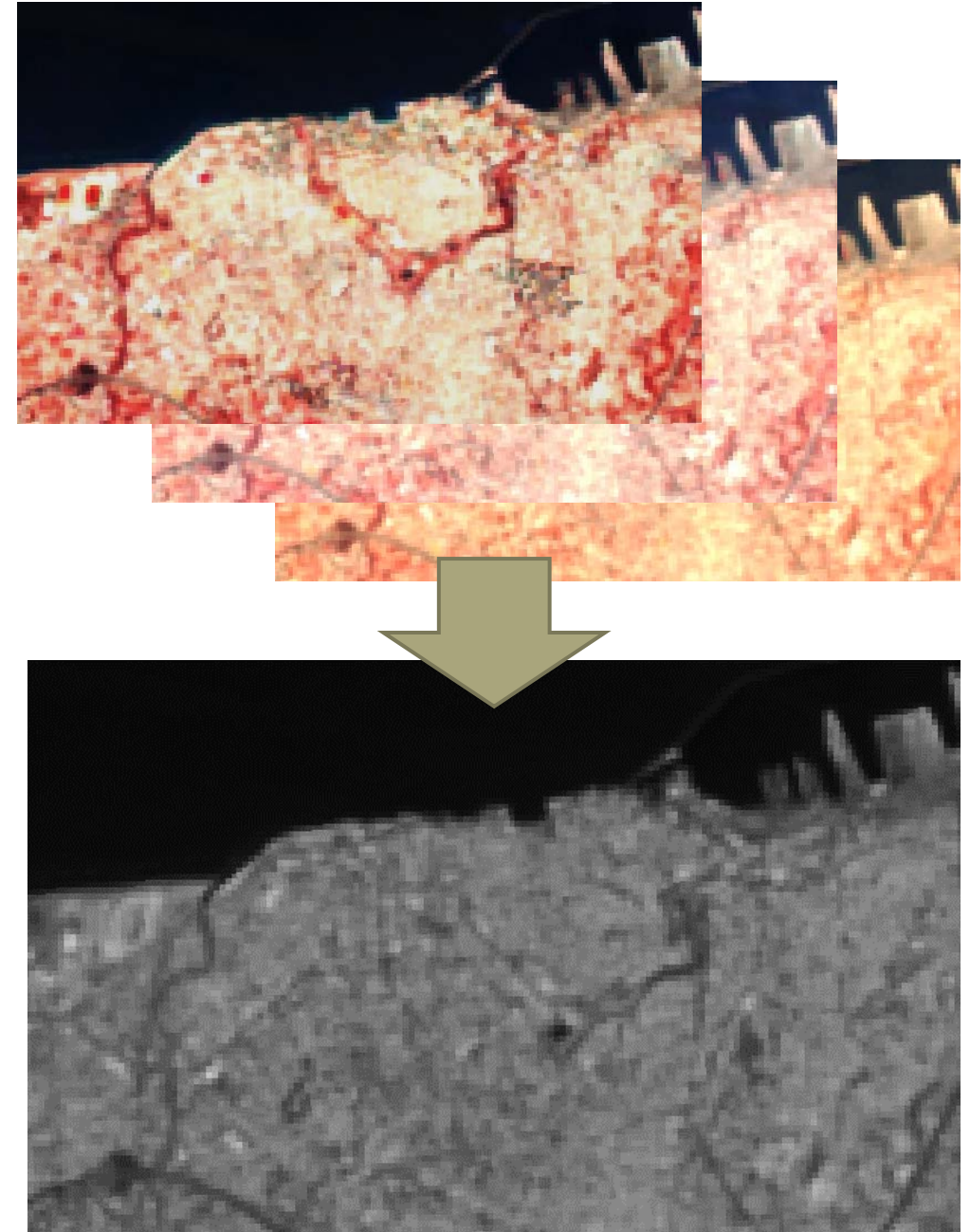
› Surface Albedo

the surface ability to reflect the incoming direct and diffused irradiance at all wavelengths and towards all possible angles

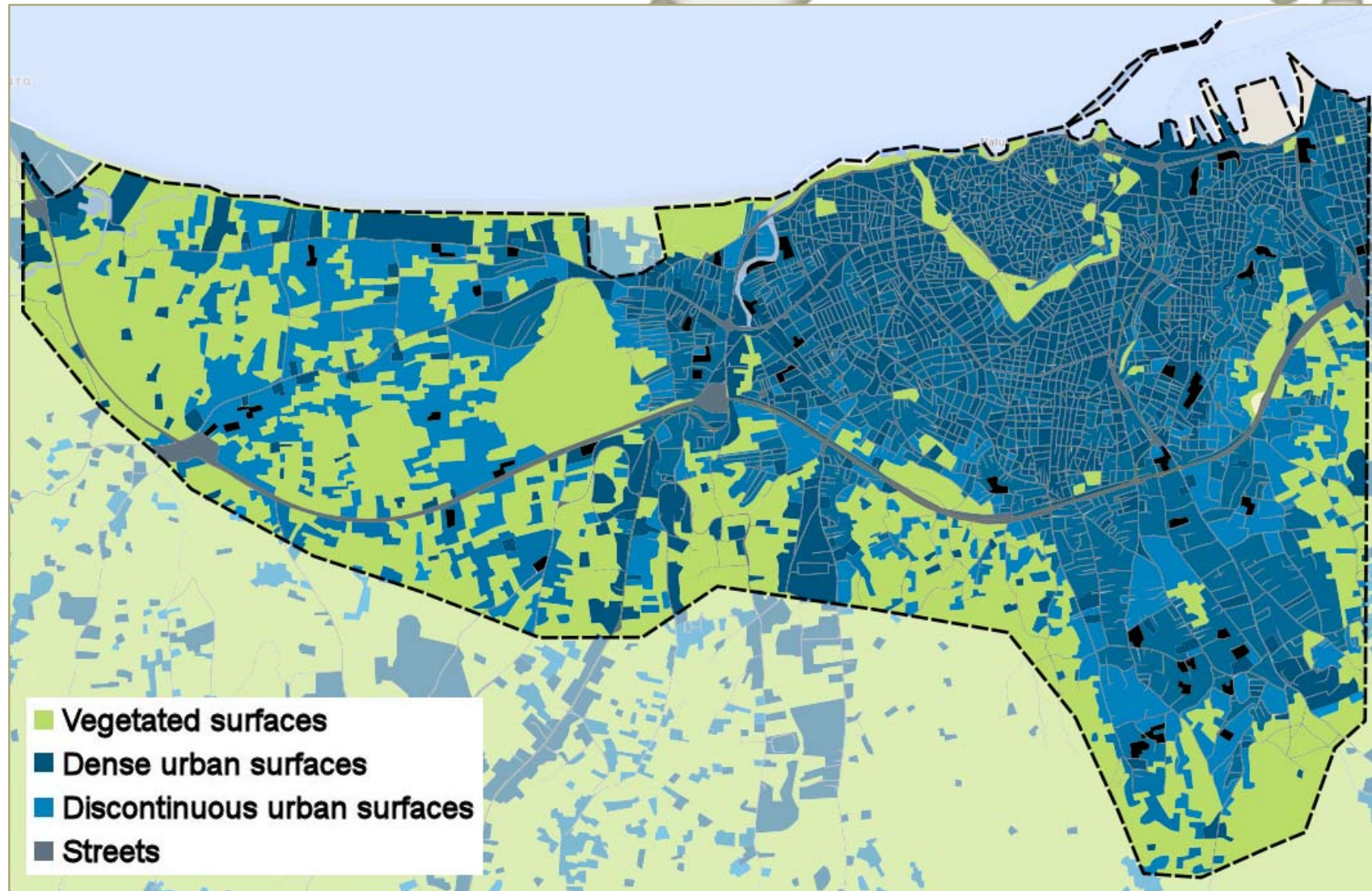
Remote Sensing data

high resolution optical imagery

Frey, C. M. and Parlow, E., 2009. Geometry effect on the estimation of band reflectance in an urban area. *Theoretical and Applied Climatology*, 96, 395 – 406.



STUDY AREA

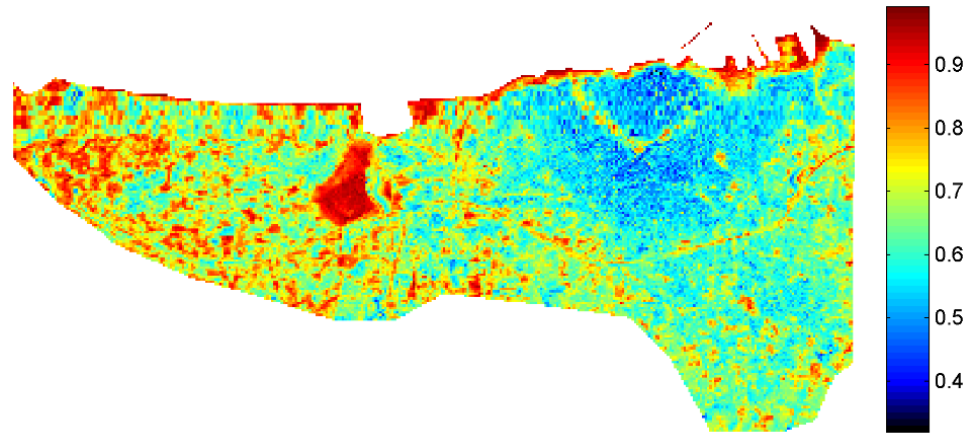


Urban Atlas Land Use polygons

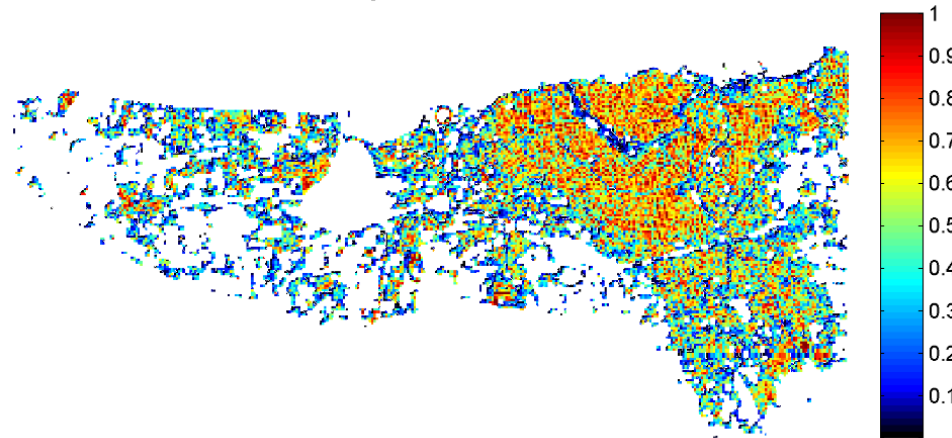
Heraklion, Greece

LCZ PARAMETERS ESTIMATION USING EO DATA

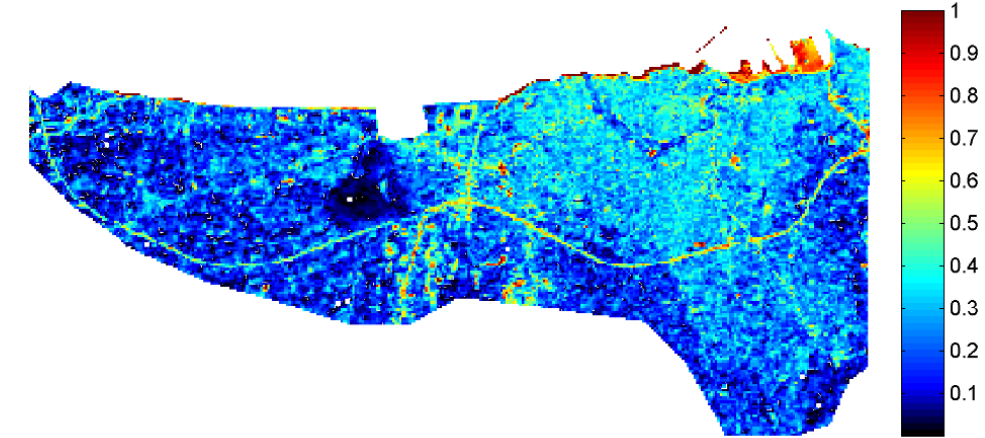
Sky view factor



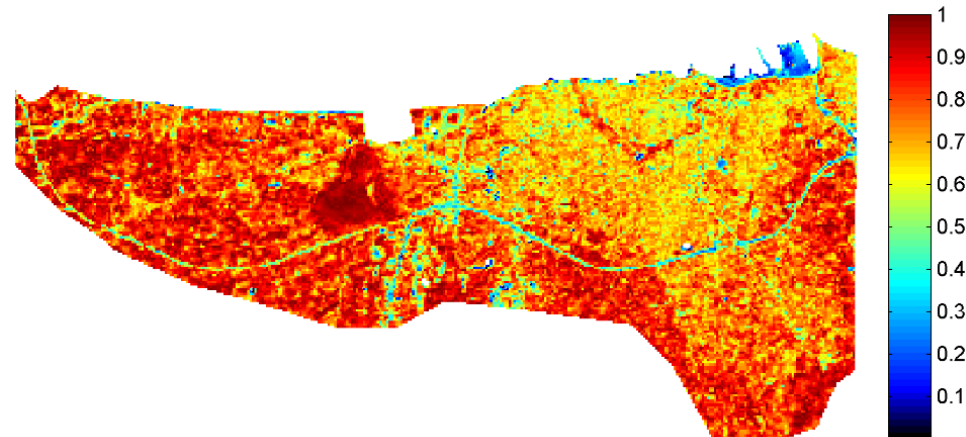
Building Surface Fraction



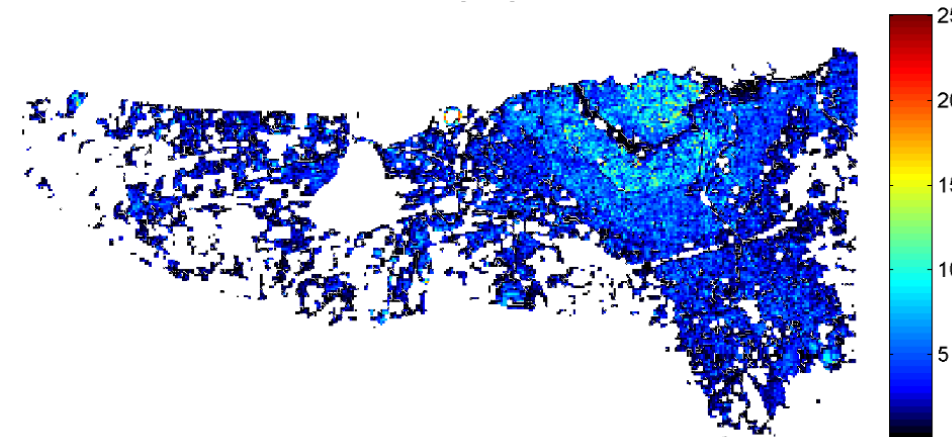
Impervious Surface Fraction



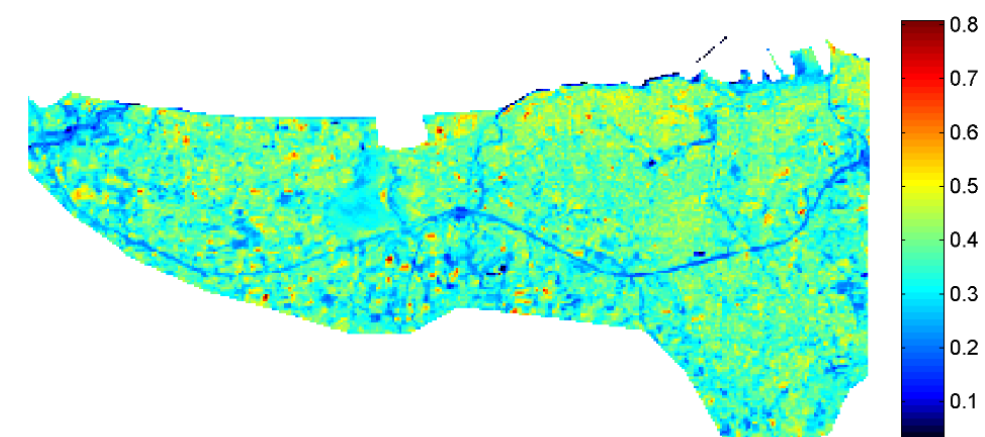
Pervious Surface Fraction



Mean Building /Tree Height (m)



Surface Albedo



IDENTIFYING THE LCZ

Identify Local Climate Zones

File Parameters Post-Processing Help

Local Climate Zones

Choose the parameters you want to include in your analysis and change the boundaries at will

Sky view factor 0.2 - 0.6 0 1 0 1

Aspect ratio H/W 0.75 - 1.5 0 3 0 3

Mean building/tree height (m) 3 - 10 0 50 0 50

Terrain roughness class 6 - 6 1 8 1 8

Building surface fraction (%) 40 - 70 0 100 0 100

Impervious surface fraction (%) 20 - 50 0 100 0 100

Pervious surface fraction (%) 0 - 30 0 100 0 100

Surface admittance (J m-2 s-1/2 K-1) 1200 - 1800 0 2500 0 2500

Albedo 0.1 - 0.2 0 1 0 1

Anthropogenic heat flux (W m-2) 0 - 75 0 400 0 400

Calculate Zone

choose a zone from below to reset

LCZ1 LCZ2 LCZ3 LCZ4 LCZ5 LCZ6

LCZ7 LCZ8 LCZ9 LCZD LCZE LCZF

User-defined Zones

NA Load Zone

C:\Users\ZinaMitraka\Copy\current\LCZsGU\stack03_crop03.tif

Moving Window Average

Moving Window Post Processing

A moving window is considered around each pixel and if more than the percentage of pixels in the window are found to belong in the same LCZ then the whole window is assigned to that zone

Use post processing moving window

Window size: 5 pixels

Window shape: circle

Percentage in window: 100 %

Input Parameters Average

Computes average for input parameters using moving window:

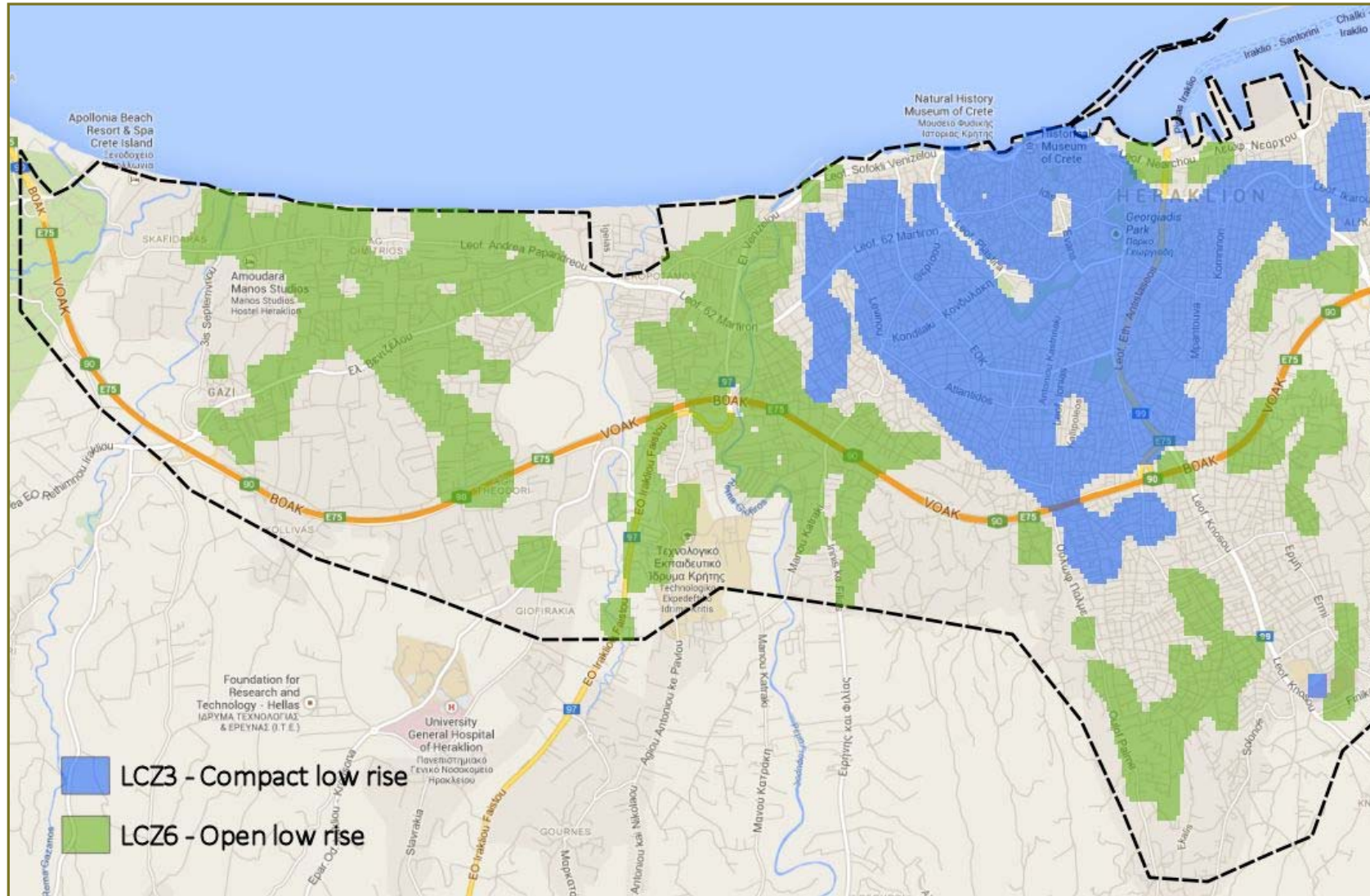
Window size: 3

Method to use: Average filter

Calculate Average

- › *multiple sources* of information result in products of *different scales*
- › *need for a common scale* to proceed with the identification of possible LCZ
- › parameters were aggregated in a 90 m × 90 m cells grid and
- › a 5 × 5 cells circular moving window was considered, since the minimum diameter of a LCZ is 400 – 1000 m

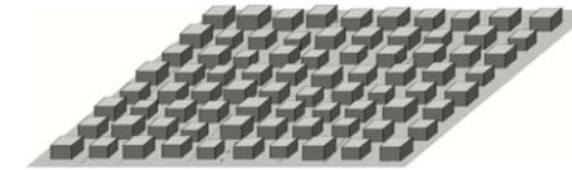
LCZ CLASSIFICATION



Blue corresponds to LCZ3 – Compact low rise and green to LCZ6 – Open low rise.

LCZ3 – Compact low rise

High angle

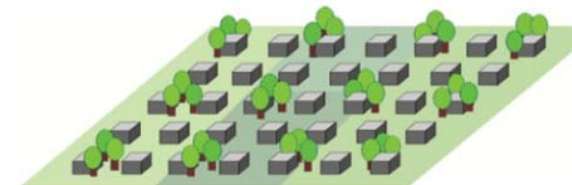


Low level



LCZ6 – Open low rise

High angle



Low level



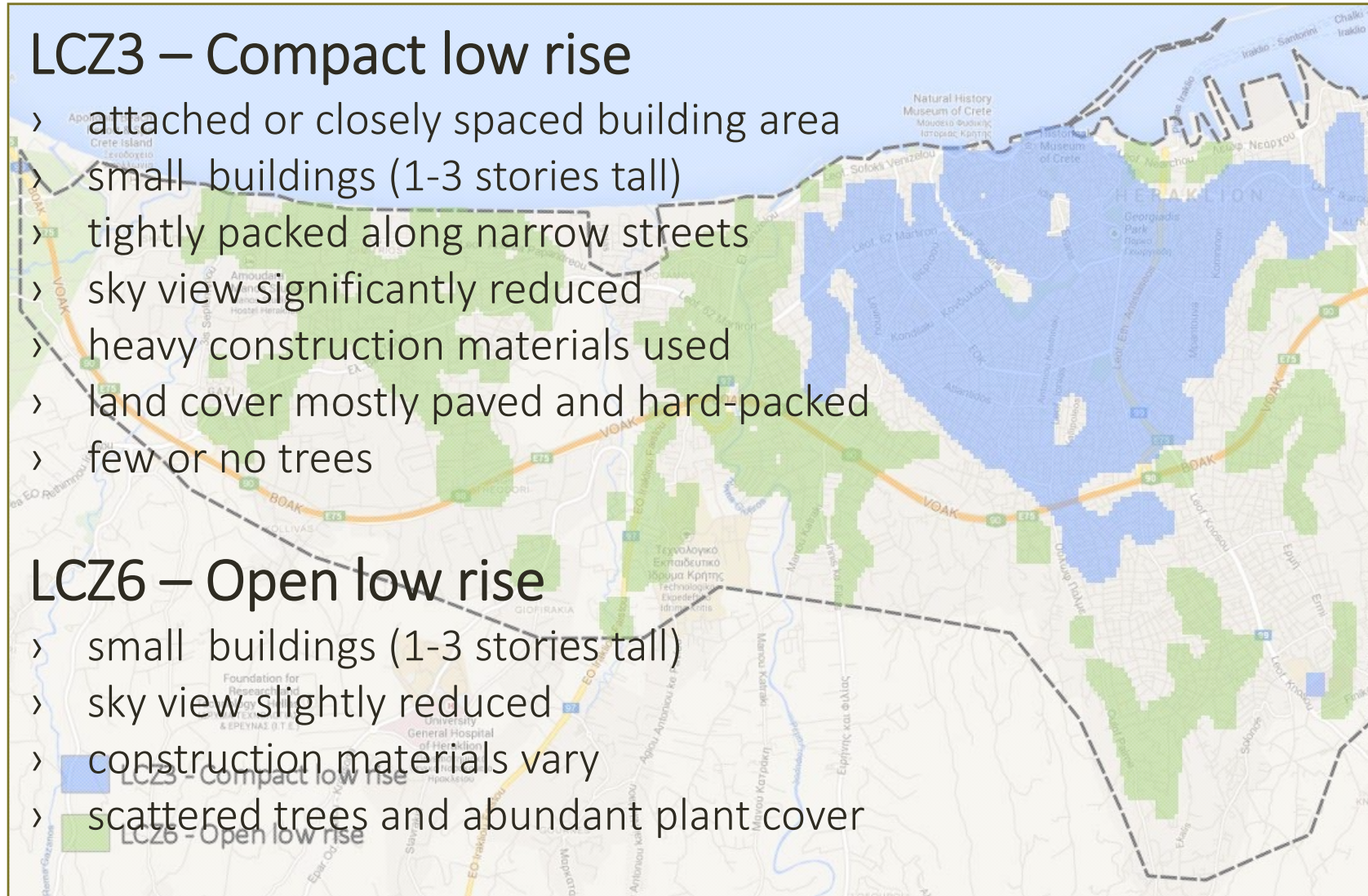
LCZ CLASSIFICATION

LCZ3 – Compact low rise

- › attached or closely spaced building area
- › small buildings (1-3 stories tall)
- › tightly packed along narrow streets
- › sky view significantly reduced
- › heavy construction materials used
- › land cover mostly paved and hard-packed
- › few or no trees

LCZ6 – Open low rise

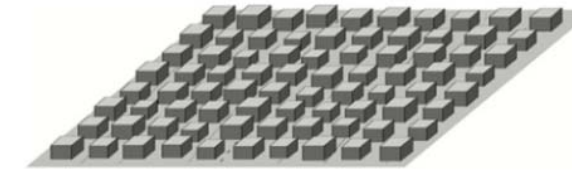
- › small buildings (1-3 stories tall)
- › sky view slightly reduced
- › construction materials vary
- › scattered trees and abundant plant cover



Blue corresponds to LCZ3 – Compact low rise and green to LCZ6 – Open low rise.

LCZ3 – Compact low rise

High angle

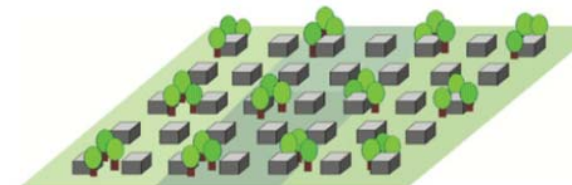


Low level



LCZ6 – Open low rise

High angle

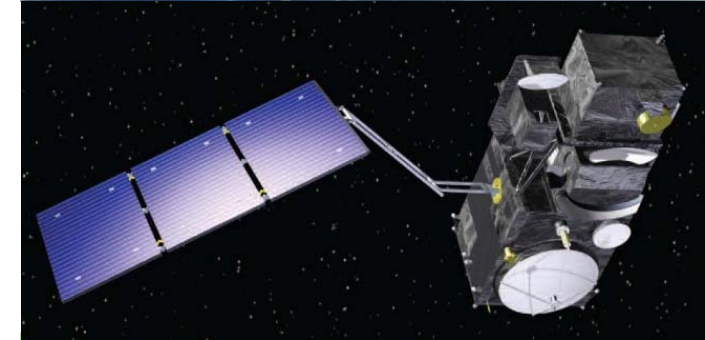
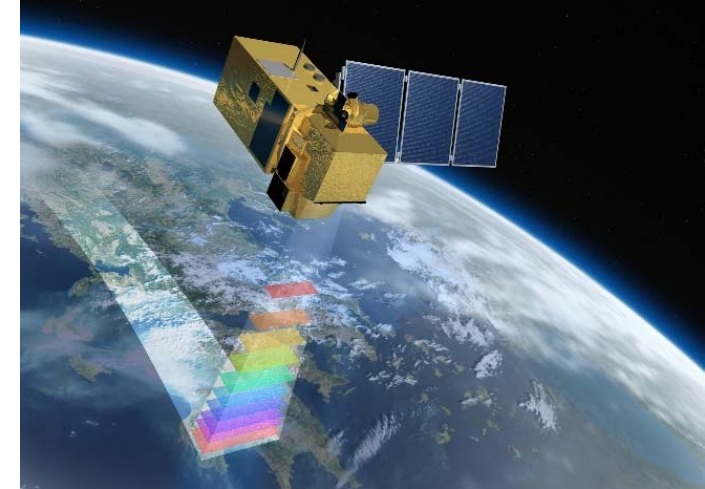


Low level



CONCLUSIONS AND OUTLOOK

- › *EO data* can be used *to quantify* the set of metadata necessary *to identify the LCZs of urban areas*
- › Individual *EO products*, as well as the LCZ classification itself, can be used to urban climate modeling and studies with ultimate goal *to assist urban planning and decision making*
- › Future research includes the *investigation of more urban parameters extraction using EO data*
- › The ultimate goal is to develop *a methodology, adapted to the Copernicus Sentinels*, to standardize the LCZ mapping



Thank you for your attention...