SEVENTH FRAMEWORK PROGRAMME
THEME 6: Environment (including climate change)

Contract for: **Collaborative Project**

D.3.2.1
GIS data maps of energy and water fluxes, pollution concentrations, land cover and vegetation

Project acronym:	BRIDGE
Project full title:	sustainaBle uRban planning Decision support accountinG for urban mEtabolism
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0.1	Sept 25/09	Donatella Spano (CMCC) Serena Marras (CMCC)	Including contributions from CMCC and SOTON
0.2	Oct 16/09	Donatella Spano (CMCC) Serena Marras (CMCC)	Further contributions from UHEL, CNR-IBIMET, and KCL added; IETU and NKUA still missing
0.2	Oct 30/09	Donatella Spano (CMCC) Serena Marras (CMCC)	Contribution from IETU added. We added information for NKUA using a file sent in July 2009
0.2	Nov 11/09	Donatella Spano (CMCC) Serena Marras (CMCC)	Further information about each case studies added
0.3	Nov 23/09	Donatella Spano (CMCC) Serena Marras (CMCC)	Updates from case studies included. NKUA contact info is still missing. Format according to BRIDGE deliverable templates.
0.4	Nov 26/09	Donatella Spano (CMCC) Serena Marras (CMCC)	Updates from case studies included.
1.0	Nov 30/09	Donatella Spano (CMCC) Serena Marras (CMCC)	Updates from case studies, KCL, UHEL and NKUA included.

Table of Contents

1. Introduction

The city is a complex system that, in order to maintain its vital functions, consumes materials and energy, accumulates materials and releases different forms of waste. In the BRIDGE (sustainaBle uRban plannIng Decision support accountinG for urban mEtabolism) project, the concept of "*urban metabolism*" is used to indicate the exchange and transformation of energy and matter between a city and its environment. Urban surface structures, such as buildings, significantly influence the **water balance**, the **energy balance** and **air quality**. In addition, land use change due to construction of buildings, roads and factories, determine major changes at the regional scale. Exchanges of energy, heat, moisture, carbon and pollutant are then measured and modelled, during the project, using recent advances in urban climatology.

The role of WP3 is to collect and analyze valuable datasets and to describe over time methodologies used to estimate urban exchanges. Five European cities have been selected (Helsinki, Athens, London, Firenze and Gliwice) as representative of the different city typologies and influenced by different policy and resource availability. For each case study, direct measurements will be performed in order to estimate urban exchanges and models will be used to simulate and predict these fluxes. In addition , the role of land use in relation to urban pattern and typology will be assessed using remote sensing data and methodologies.

1.1 Purpose of the document

This document is the D.3.2_Remote Sensing Data Collection and Analysis. Task 3.2 has the role to systematically monitor the main fluxes using remote sensing techniques for each case study (Helsinki, Athens, London, Firenze and Gliwice).

The **aim of this document** is to collect information on remote sensing data available for each case study of the BRIDGE Project. In particular, it contains information on data spatio-temporal distributions, methodologies used to provide the data and maps of physical parameters. This information will be useful to know the state-of-art in remote sensing studies and data for each city involved. The final products of Task 3.2, in fact, are GIS data and maps of energy and water fluxes, pollution concentrations, land cover and vegetation.

1.2 Definitions and Acronyms

Acronyms

CoP	Community of Practice
DSS	Decision Support System
GIS	Geographical Information System
RS	Remote Sensing
DEM	Digital Elevation Model
ASTER	Advanced Thermal Emission and Reflection Radiometer

1.3 Document References

Chrysoulakis, N., Abrams, M., Kamarianakis, Y. and Stanisławski, m., 2009. Validation of the ASTER derived Global DEM product (GDEM) for the area of Greece. ISPRS Journal of Photogrammetry and Remote Sensing (accepted).

Fuller, R.M., Smith, G.M., Sanderson, J.M., Hill, R.A., & Thomson, A.G. 2001. The UK Land Cover Map 2000: construction of a parcel-based vector map from satellite images. *Cartographic J:* **39** 15-25.

Jiménez-Munõz, J.C. and Sobrino, J.A., 2003. A generalized single-channel method for retrieving land surface temperature. Journal of Geophysical Research, 108 (D22), 4688, doi:10.1029/2003JD003480.

Liang, S., 2001. Narrowband to Broadband Conversion of Land Surface Albedo. I. Algorithms, *Remote Sensing of Environment*, vol. 76, pp. 213-238.

Liang, S., 2004. Quantitative Remote Sensing of Land Surfaces, John Wiley and Sons, Inc., 534 pages.

Sobrino, J.A., Jimenez-Munoz, J.C. and Paolini, L., 2004. Land surface temperature retrieval from LANDSAT TM 5. *Remote Sensing of Environment*, vol. 90, pp. 434-440.

Stathopoulou, M., Cartalis, C. and Petrakis, M., 2007. Integrating Corine Land Cover data and Landsat TM for surface emissivity definition: application to the urban area of Athens, Greece. *International Journal of Remote Sensing*, vol. 28(15), pp. 3291 – 3304.

1.4 Project Overview

Urban metabolism considers a city as a system and distinguishes between energy and material flows. “Metabolic” studies are usually top-down approaches that assess the inputs and outputs of food, water, energy, etc. from a city, or that compare the metabolic process of several cities. In contrast, bottom-up approaches are based on quantitative estimates of urban metabolism components at local scale, considering the urban metabolism as the 3D exchange and transformation of energy and matter between a city and its environment. Recent advances in bio-physical sciences have led to new methods to estimate energy, water, carbon and pollutants fluxes. However, there is poor communication of new knowledge to end-users, such as planners, architects and engineers.

BRIDGE aims at illustrating the advantages of considering environmental issues in urban planning. BRIDGE will not perform a complete life cycle analysis or whole system urban metabolism, but rather focuses on specific metabolism components (energy, water, carbon, pollutants). BRIDGE’s main goal is to develop a Decision Support System (DSS) which has the potential to propose modifications on the metabolism of urban systems towards sustainability.

BRIDGE is a joint effort of 14 Organizations from 11 EU countries. Helsinki, Athens, London, Firenze and Gliwice have been selected as case study cities. The project uses a “Community of Practice” approach, which means that local stakeholders and scientists of the BRIDGE meet on a regular basis to learn from each other. The end-users are therefore involved in the project from the beginning. The energy and water fluxes are measured and modelled at local scale. The fluxes of carbon and pollutants are modelled and their spatio-temporal distributions are estimated. These fluxes are simulated in a 3D context and also dynamically by using state-of-the-art numerical models, which normally simulate the complexity of the urban dynamical process exploiting the power and capabilities of modern computer platforms. The output of the above models lead to indicators which define the state of the urban environment. The end-users decide on the objectives that correspond to their needs and determine objectives’ relative importance. Once the objectives have been determined, a set of associated criteria are developed to link the objectives with the indicators. BRIDGE integrate key environmental and socio-economic considerations into urban planning through Strategic Environmental Assessment. The BRIDGE DSS evaluates how planning alternatives can modify the physical flows of the above urban metabolism components. A Multi-criteria Decision Making approach has been adopted in BRIDGE DSS. To cope with the complexity of urban metabolism issues, the objectives measure the intensity of the interactions among the different elements in the system and its environment. The objectives are related to the fluxes of energy, water, carbon and pollutants in the case studies. The evaluation of the performance of each

alternative is done in accordance with the developed scales for each criterion to measure the performance of individual alternatives.

Several studies have addressed urban metabolism issues, but few have integrated the development of numerical tools and methodologies for the analysis of fluxes between a city and its environment with its validation and application in terms of future development alternatives, based on environmental and socio-economic indicators for baseline and extreme situations. The innovation of BRIDGE lies in the development of a DSS integrating the bio-physical observations with socio-economic issues. It allows end-users to evaluate several urban planning alternatives based on their initial identification of planning objectives. In this way, sustainable planning strategies will be proposed based on quantitative assessments of energy, water, carbon and pollutants fluxes.

2. Summary

Task 3.2 aims to collect satellite, airborne and ground-based remote sensing data in order to produce maps of energy and water fluxes, pollution concentration, land cover and vegetation.

For each case study, the following data will be available:

- Maps of surface albedo in the visible part of the spectrum (NKUA) by satellite data
- Urban land cover/land use maps (NKUA, SOTON, UHEL)
- Land surface temperature (NKUA, KCL) by satellite data
- Morphological characteristics and anthropogenic heat flux (KCL)
- Maps of sensible heat flux based on different modelling approaches (KCL, CMCC)
- Maps of surface emissivity (CMCC, NKUA) by modelling and satellite data
- 3D maps of cities
- Particulate profiles and PBL characteristics (CNR) by LIDAR
- Airborne images (UHEL, KCL, CNR)
- Digital Elevation Models (FORTH)
- High resolution satellite data products (FORTH)

More details on data spatial and temporal variability and methodologies used are in the following sections.

2.1 Partners involved

1. CNR
Consiglio Nazionale delle Ricerche, Italy
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7. UHEL
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3. Case Studies

3.1 Helsinki

Data already existing

- *GIS data.* Examples are given in Figure 1.
- *Aerial images*

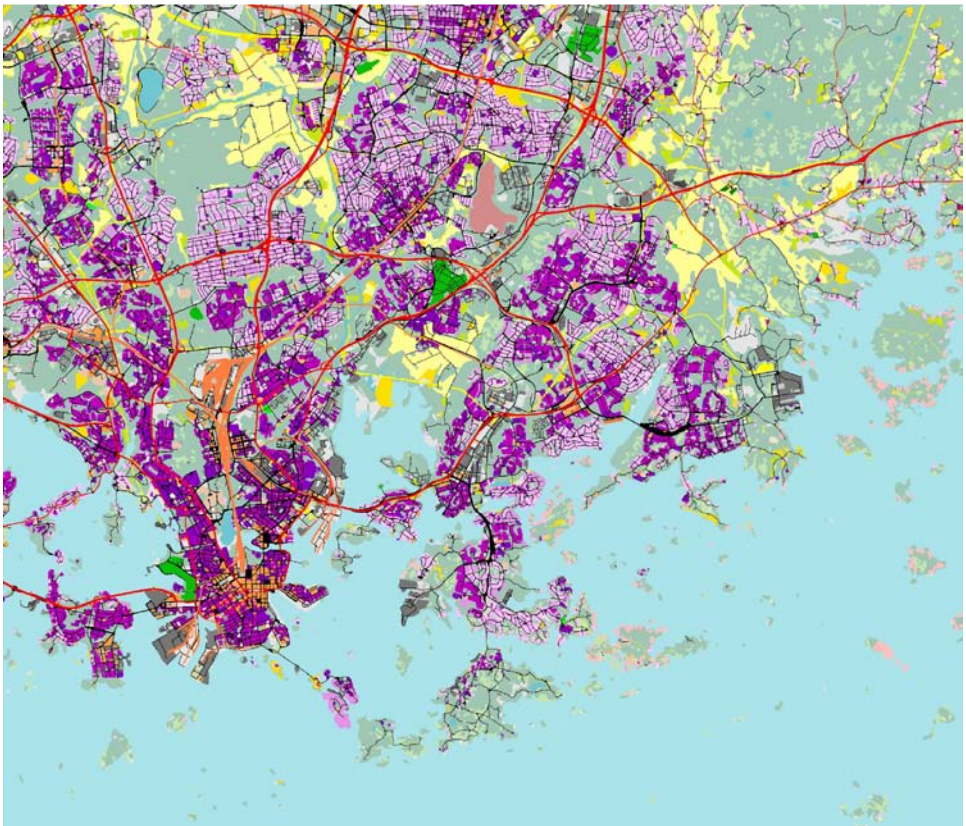

Figure 1. Helsinki Land Use Map.

Table 1. Land Use Classification in Slices. Raster image in 10 m x 10 m pixels, coordinate system EUREF-FIN/TM35FIN = ETRS89, Transverse Mercator, Zone 35.

Land use class	Colour
A. Housing and recreational areas	(main class)
A1. Housing areas	(main class)
A11. Block house areas	
A12. Small house areas	(main class)
A121. Row and attached small houses	
A122. Detached housing areas	
A2. Holiday and travel sites	(main class)

Land use class	Colour
A21. Holiday resorts and cottage areas	
A22. Areas of travel services and holidaymaking	(main class)
A221. Camping and caravan sites	(no data)
A222. Allotments and cultivation plots	(no data)
A3. Other recreational areas	(main class)
A31. Areas of entertainment services	(no data)
A32. Areas of sport and recreational services	
A33. Parks	
B. Business, management and industrial areas	(main class)
B1. Areas of business and management	(main class)
B11. Commercial and office buildings	(main class)
B111. Commercial buildings	
B112. . Office buildings	
B12. Public buildings	
B2. Industrial and storage areas	(main class)
B21. Industrial areas	
B22. Storage areas	(main class)
B221. Storage buildings	
B222. Other storage areas	(no data)
C. Areas of supporting functions	(main class)
C1. Transportation areas	
C11. Road transportation areas	
C111. Public roads	
C112. Streets and alleys (incl. in C11)	(no data)
C113. Private roads (incl. in C11)	(no data)
C12. Railway areas	
C13. Areas of air traffic and aviation	
C14. Port areas	
C15. Other transportation areas	
C2. Areas of civil engineering	
C21. Environmental engineering and management	
C22. Energy management	
C23. Water management	(no data)
C24. Other sites of civil engineering & management	
D. Rock and soil extraction sites	(main class)
D1. Rock and soil extraction sites	(main class)

Land use class	Colour
D11. Rock and mineral extraction sites	(main class)
D111. Mines	
D112. Quarries	
D12. Soil extraction sites	(main class)
D121. Peat production sites	
D122. Gravel and sand extraction sites	
D123. Other soil extraction sites	
E. Agricultural areas	(main class)
E1. Agricultural land in production use	(main class)
E11. Fields	
E12. Perennial meads and grasslands	
E13. Perennial and covered plantations	(main class)
E131. Fruit and berry plantations	
E132. Nursery gardens and covered cultivations	
E2. Other agricultural land	(main class)
E21. Unused agricultural land	(main class)
E211. Long-term fallows	
E212. Agricultural land permanently removed from productive use	
E22. Constructed agricultural land	(main class)
E221. Farm houses and outbuildings	
E222. Other constructed land related to agriculture	
F. Forest management areas	(main class)
F1. Productive forestry areas	(main class)
F11. Forests	
F12. Scrubland	
G. Other land areas	(main class)
G1. Brownfields	
G2. Other land areas	
H. Territorial waters	(main class)
H1. Inland water areas	(main class)
H11. Natural waters	(main class)
H111. Unregulated natural waters	
H112. Regulated natural waters	
H12. Other territorial waters	(main class)
H121. Unregulated waters	

Land use class	Colour
H122. Regulated waters	
H2. Sea areas	

Data collected during the project

- *3D datasets* can be possibly collected .
- *GIS data*, if more data with the detailed specifications are needed, they can be provided.
- *Satellite data.*
- *Airborne acquired images*, if more data with the detailed specifications are needed, they can be provided.
- *Digital Elevation Model (DEM):* Extraction and post processed ASTER GDEM for the broader area of Helsinki was provided by FORTH. The product was delivered in both Geographic WGS84 and UTM WGS84 projections with EGM96 vertical datum. Its spatial resolution is 30 m.

Contact info

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3.2 Athens

Data already existing

- *3D Maps*
- *GIS data*

1. Vector data map of Greece used to define the Prefectures of Greece as well as the geographical boundaries of the Attica Prefecture in which Athens is located (Figure 2). Projection info: Lambert Azimuthal Equal-area, map units: meters.

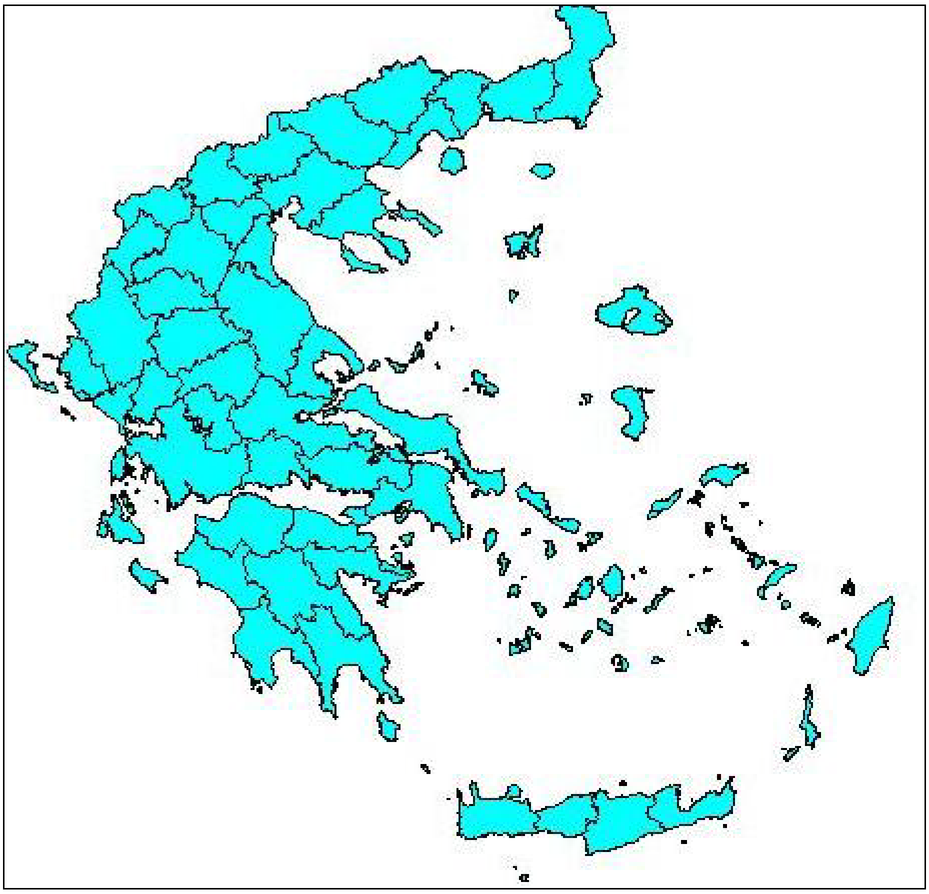

Figure 2. Administrative boundaries for Greece.

2. Corine Land Cover 2000 database of Greece: Vector data map at the scale of 1: 100 000, used to describe land cover and land use types across the Prefecture of Attica (including Athens and the Egaleo test site) for the reference year 2000 (Figure 3). The database uses 44 land cover/use classes organized into 5 main categories: 1.Artificial surfaces 2. Agricultural areas 3. Forests and semi-natural areas 4. Wetlands and 5. Water bodies. Projection info: GCS_ETRS_1989, map units: degrees

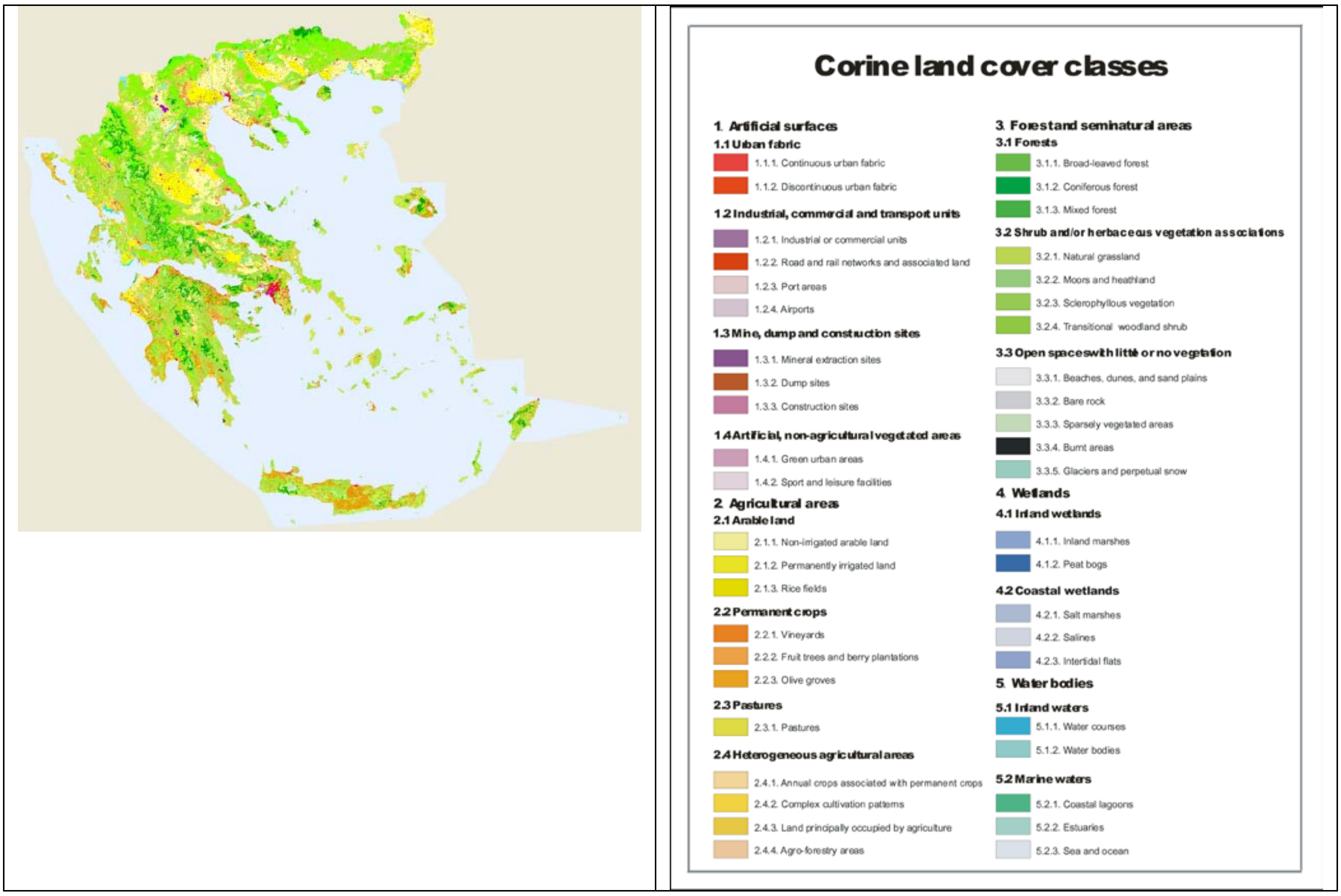

Figure 3. CORINE Land Cover Data for Greece.

- *Aerial images*
- *Satellite data*

On a local scale perspective, processing of the satellite data in the visible part of the spectrum can be performed leading to the measurement and mapping of the following geophysical and biophysical variables for Athens (including the Egaleo test site):

1. Narrowband (spectral) and broadband ***surface albedo*** at 30m spatial resolution produced from the Landsat TM sensor. The wavelengths (0.25-5.0 μm) correspond to total shortwave broadband albedo, whereas (0.4-0.7 μm) and (0.7-5.0 μm) correspond to visible and near-infrared broadband albedos (Figures 4, 5 and 6). The methodology applied is described in Liang et al. (2002) and Liang (2004).

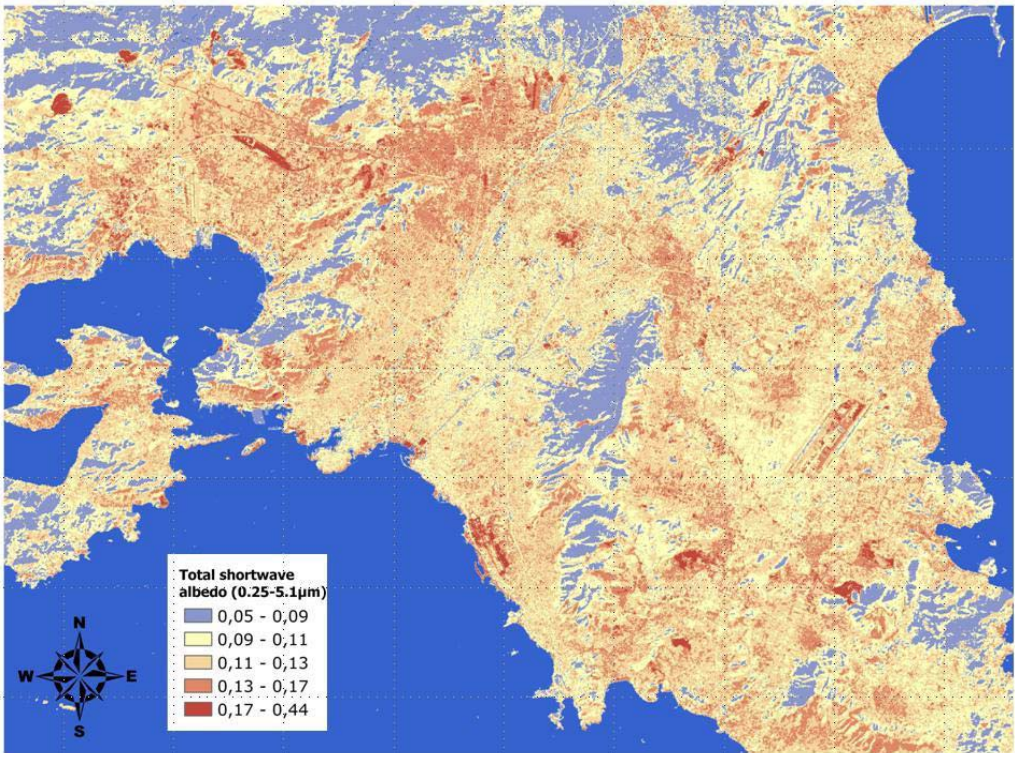

Figure 4. Example image of total shortwave albedo for Athens on 8/4/2005.

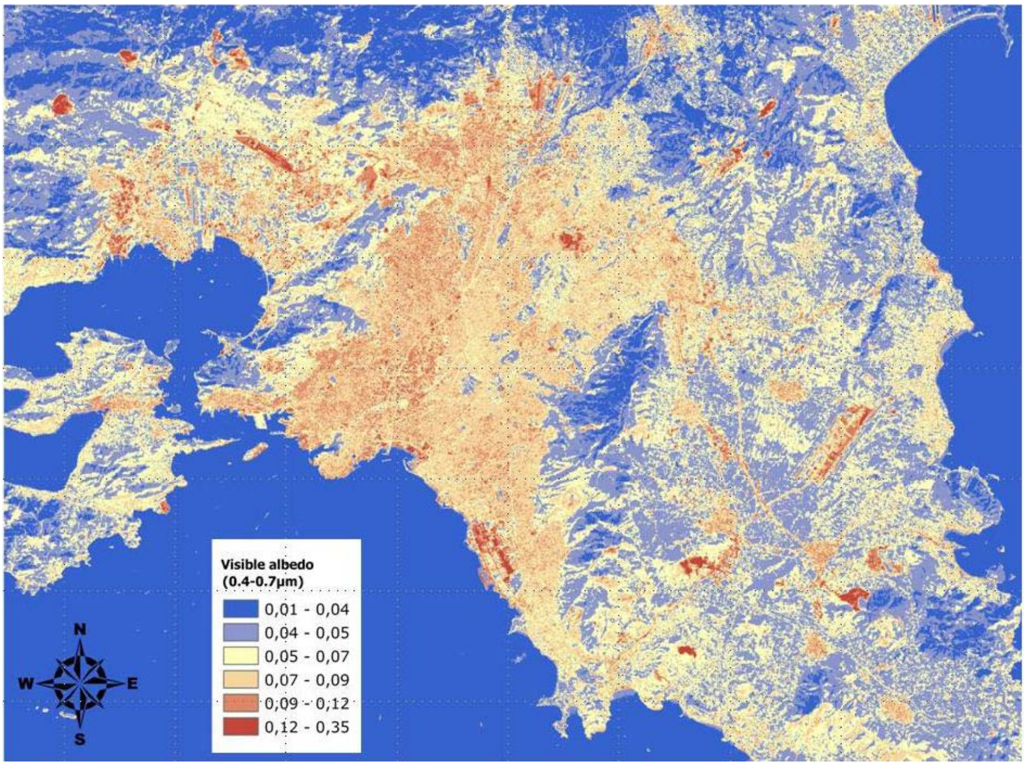

Figure 5. Example image of visible albedo for Athens on 8/4/2005.

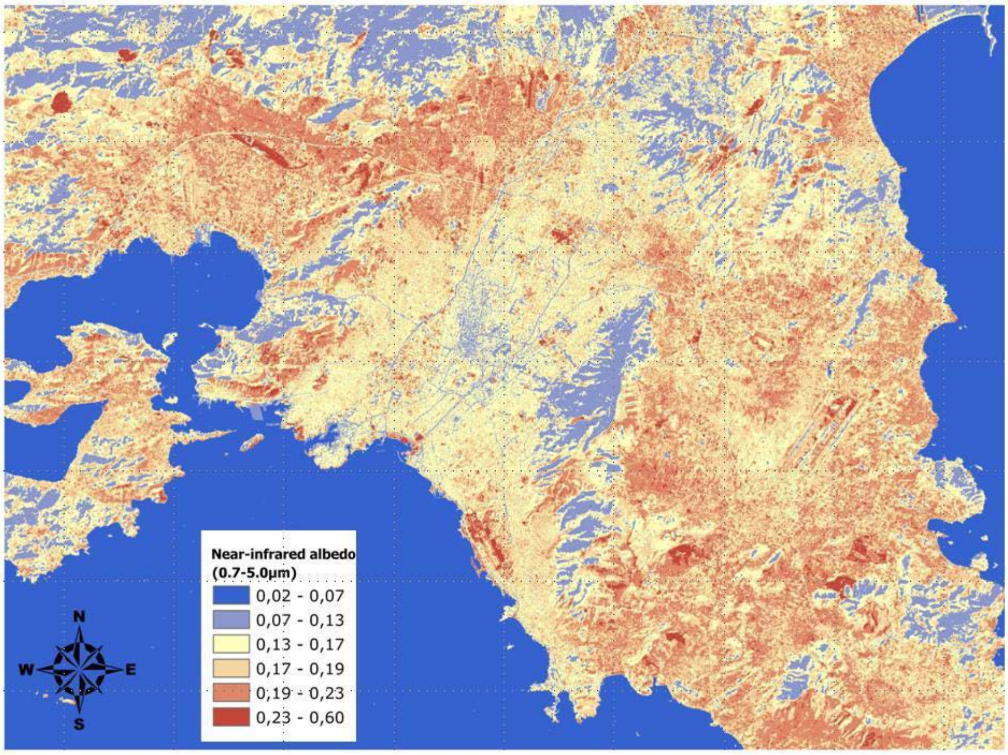

Figure 6. Example image of near-infrared albedo for Athens on 8/4/2005.

2. ***Urban vegetation*** as derived from the multispectral vegetation index NDVI at 30-m spatial resolution produced from Landsat TM (Figure 7)

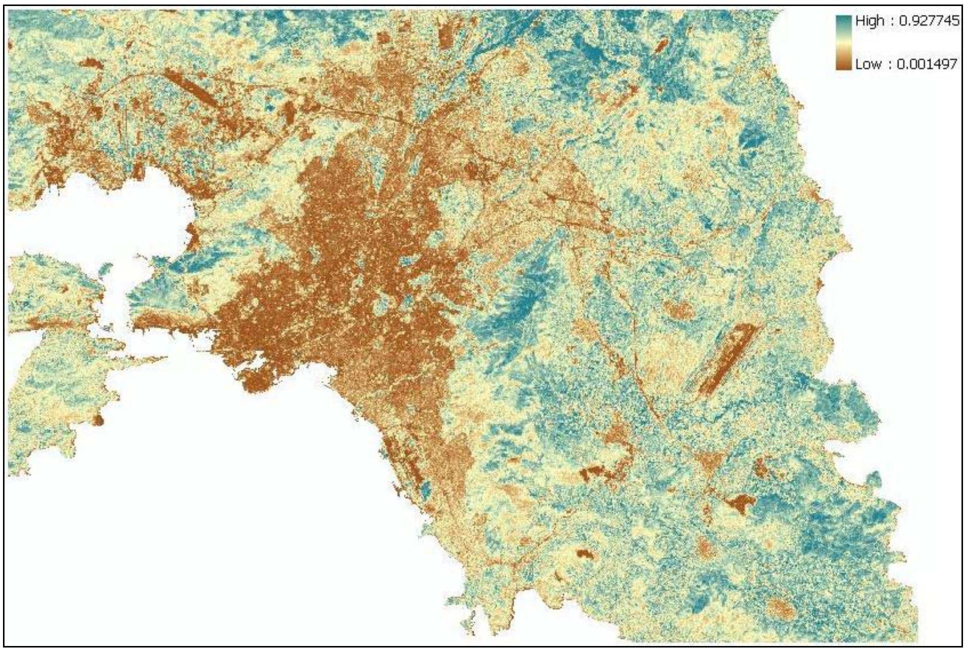

Figure 7. Composite NDVI image of Athens for the warm season (April – August 2005).

3. ***Land surface emissivity*** (LSE) in the thermal infrared at 30-m spatial resolution produced from Landsat TM (Figure 8). The methodology applied is described in Sobrino et al. (2004) and Stathopoulou et al. (2007).

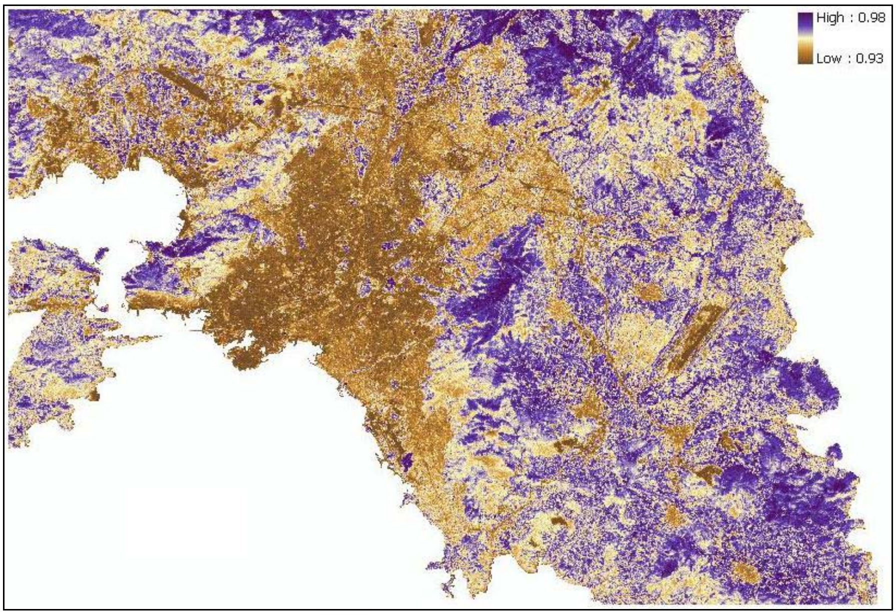

Figure 8. Seasonal surface emissivity image of Athens (April – August 2005).

Furthermore, processing of the satellite data in the near-infrared may lead to the measurement of the following biophysical variable for Athens:

4. ***Land surface temperature*** (LST) at 120-m spatial resolution produced from the Landsat TM sensor (Figure 9). The LST algorithm applied is the one proposed by Jiménez-Munõz and Sobrino (2003).

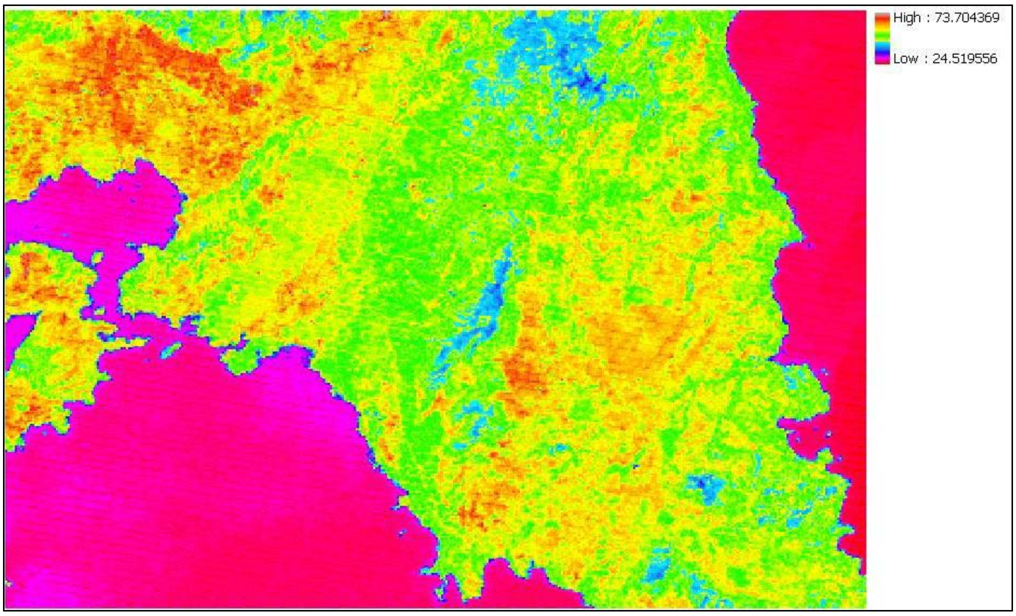

Figure 9. LST image of Athens on 10/7/2004.

Data collected during the project

- *GIS data:* Vector maps of buildings, building heights, topography, census block and road network for the Egaleo test site provided in shapefile format.
- *Satellite data*
- *Aerial images*
- *Digital Elevation Model*

  Extraction and post processed ASTER GDEM for the broader area of Athens was provided by FORTH (Figure 10). The product was delivered in both Geographic WGS84 and UTM WGS84 projections with EGM96 vertical datum. Its spatial resolution is 30 m. A validation of this product has given by Chrysoulakis et al. (2009).

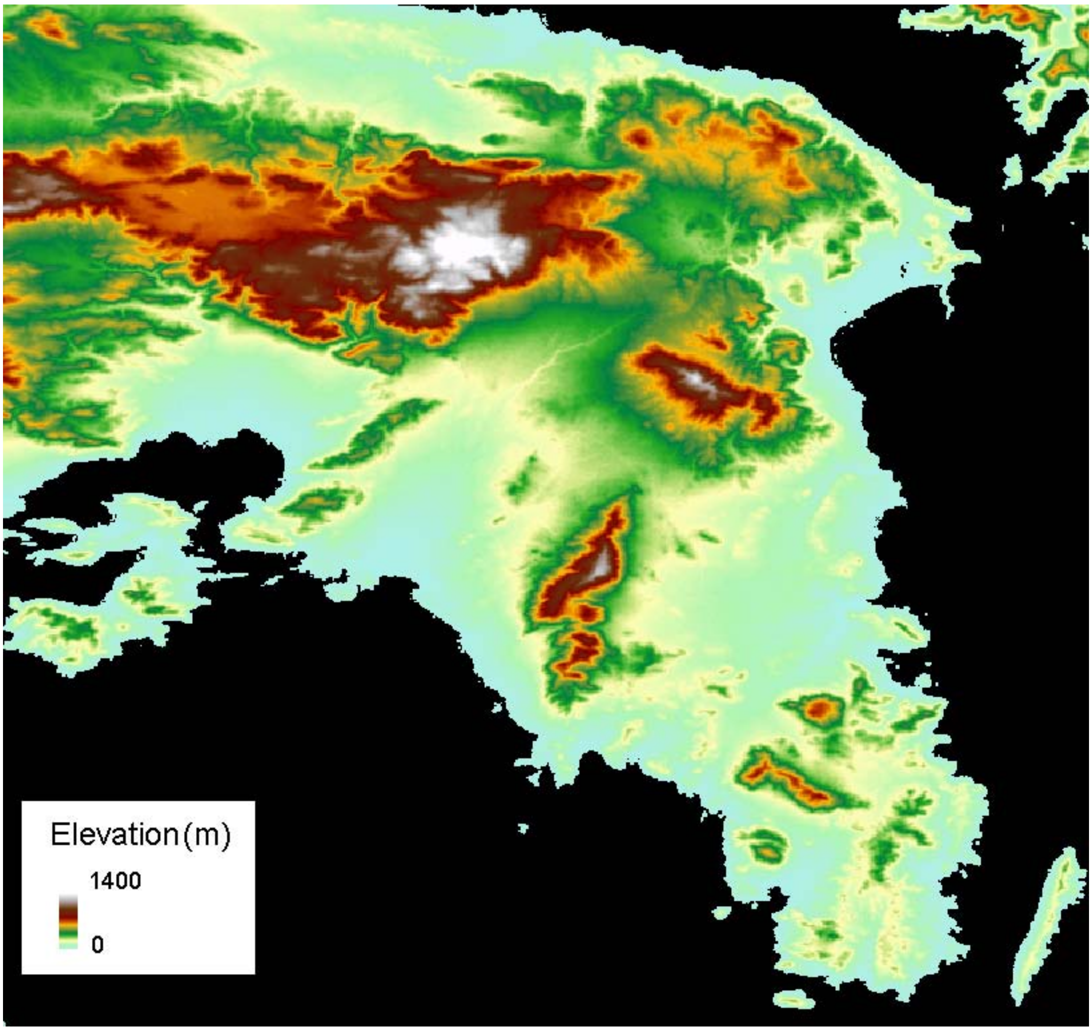

Figure 10. ASTER derived DEM for the broader area of Athens.

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3.3 London

Data already existing

- *3D Maps:*
  Virtual London, Centre for Advanced Spatial Analysis (CASA), University College London (KCL: we can not provide the raw data)
  Data: may be able to be obtained via contact through Rachel Conti (Greater London Authority according to KCL)
- *GIS data:*
  SOTON GIS data
  1 : 200 000 scale vector boundary data maps of Great Britain (Great Britain boundary data, Collins Bartholomew, UK), used to define urban features and London borough boundaries.
  The London Atmospheric Emissions Inventory (LAEI) for 2006 and forward projections (2015). This includes both the 25 m PM10 concentration map (µg m^{-3}) and the total emission predictions for London (tonnes) for each borough and emission sources (1 km grid squares).
  A 25 m^2 resolution land classification map of the UK (LCM2000, Centre of Ecology and Hydrology, UK; Fuller et al., 2001)
- *Satellite data.*
- *Aerial images:*
  KCL: Airborne (one daytime, one night time flight in August 2008), north/south transects of Greater London:
  - hyperspectral radiances measured by NERC ARSF EAGLE/HAWK sensors, broadband radiances measured by NERC ARSF ATM (Spectral bands from 400 up to 2500 nm)
  - Leica ALS50-II LiDAR
  - Leica RCD105 39 megapixel digital camera
  - Accompanied by ground based measurements

Data to be collected during the project

- *GIS data*
  SOTON GIS data
  Urban vegetation data for the Greater London Authority (GLA) has been extracted at each of the 33 London borough levels using ArcMap™ (ESRI® ArcMap ™ version 9.3). The habitat classes extracted are: Class (1) Broad leaved trees, Class (2) Coniferous trees and Classes (5-8) Grasses.
  The raster data-sets (25 m) were used to quantify the area of these land cover classes for each London borough.

  KCL GIS data
  Morphological characteristics
  - Roughness length for momentum
  - Zero plane displacement length
  - Plan area index
  - Frontal area index
  - Sky view factors

  Anthropogenic heat flux
  - further analysis of morphology, anthropogenic heat flux

  RS& GIS & Meteorological data: turbulent sensible heat flux based on different modelling approaches (Aerodynamic Roughness Method, LUMPS)

- *Satellite data*
  KCL: Landsaf Surface Temperature for London
- *Aerial images*
  KCL: 2008 Airborne observation will be repeated hopefully
- *Digital Elevation Model*
  Extraction and post processed ASTER GDEM for the broader area of London was provided by FORTH (Figure 11). The product was delivered in both Geographic WGS84 and UTM WGS84 projections with EGM96 vertical datum. Its spatial resolution is 30 m.

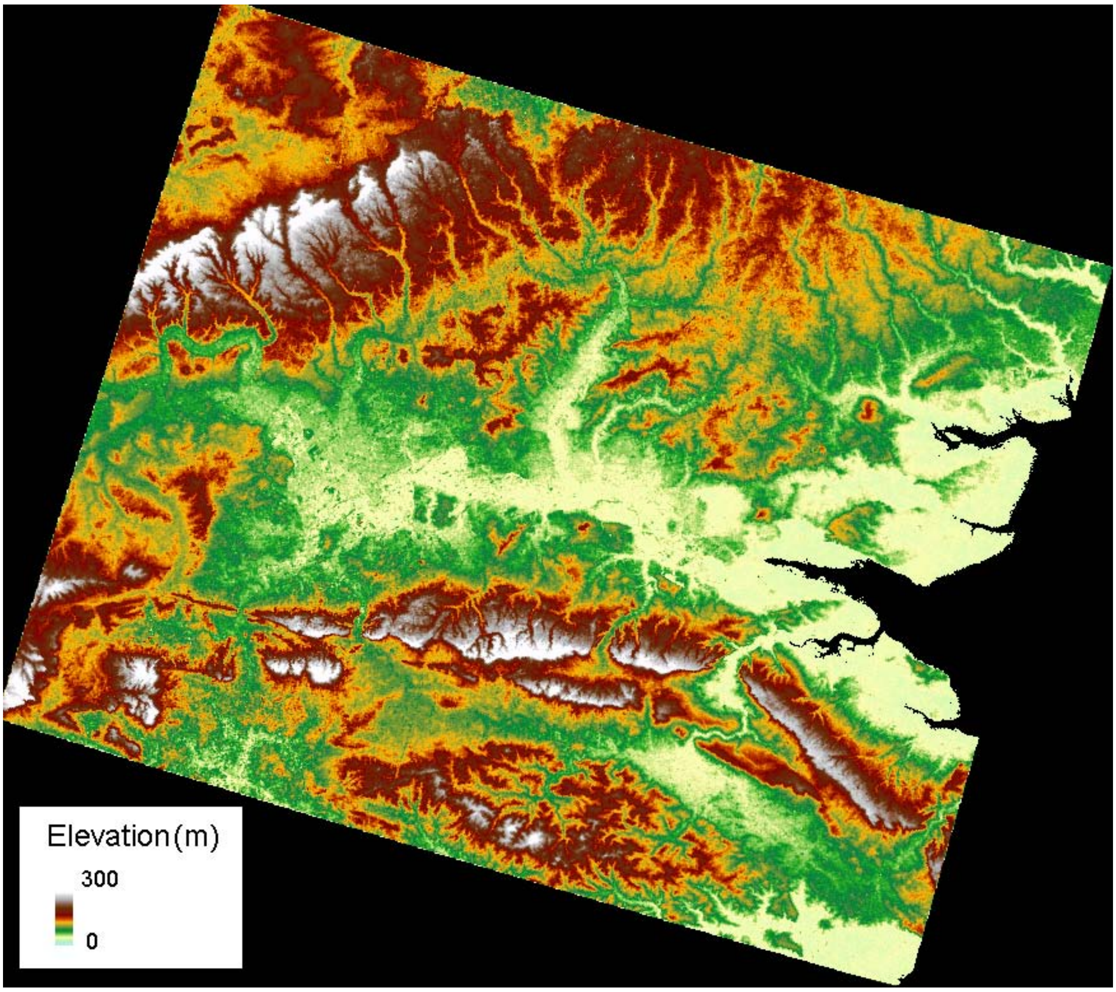

Figure 11. ASTER derived DEM for the broader area of London.

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3.4 Firenze

Data already existing

- *3D Maps:* Firenze 3D: http://sit.comune.fi.it/volo.asp
  Building height is a layer included in the CTR cartography described below
- *GIS data*
  DEM at 10m resolution if needed
  Alternatively, DEM at 90m resolution (SRTM)
  CORINE Land Cover at low resolution
- *Satellite data*
- *Aerial images:* aerial ortophoto if needed (2007? or 2003)
- *Other*
  Digital topographic maps at high resolution CTR (1:2000 scale), with layers describing roads /type etc), buildings type, (including height), green areas etc.

The products: Land Use/Land Cover data, Road Networks - Buildings, Topography, Population, Administrative units and more are now available for download at: ftp:\\149.139.16.152
username: toscano, pwd: piero1980

A CODE_LAYERS.txt for technical description (in english) is available. All layers are in shapefile format with attributes in italian language (e.g., quotagrond means base roof height).

Data collected during the project

- *Remote sensing data*
  Lidar PBL soundings (retrieving PBL characteristics + particulate profiles, ISAFOM), starting January 2010
- *GIS data*
  CMCC: Maps of sensible heat flux and surface emissivity will be produced using the ACASA/WRF model.
- *Satellite data*
- *Airborne acquired images*
  RS flight (IR + multispectral VIS-NIR) performed by ISAFOM
- *Digital Elevation Model*
  Extraction and post processed ASTER GDEM for the broader area of Firenze was provided by FORTH. The product was delivered in both Geographic WGS84 and UTM WGS84 projections with EGM96 vertical datum. Its spatial resolution is 30 m.

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3.5 Gliwice

Data already existing

- *3D Maps:* no 3D maps available
- *GIS data*
  - About 30 000 GIS coverages in Gliwice Municipal Spatial Information System (MSIS). This coverages are available on 3 access level. First is for general user, the second is for investors (one has to register) and third, restricted for the town office clerk. One may view the first two on the homepage http://test.um.gliwice.pl/portal/map
  - Gliwice MSIS contains among others map of address points, map of buildings, lots, road network, utility networks, etc.
  - Gliwice MSIS also contains Digital Elevation Model in raster format. Resolution about 2 metres.
  - IETU has several meso-scale GIS coverages concerning environment and ecology including emission of PM10 in 500 metres grid.
- *Satellite data:* No satellite data available
- *Aerial images:* aerial orthophotomap serving as a background from year 2003

Data collected during the project

- *3D Maps*
- *GIS data*
- *Satellite data*
- *Airborne acquired images*
- *Digital Elevation Model*

  Extraction and post processed ASTER GDEM for the broader area of Gliwice was provided by FORTH. The product was delivered in both Geographic WGS84 and UTM WGS84 projections with EGM96 vertical datum. Its spatial resolution is 30 m.

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Annex:

Remote Sensing measurements to be collected by each partner during the project. Methods, starting and closing date of data acquisition are also described.

Table 2. FORTH.

	participant	Foundation for Research and Technology - Hellas					
	acronym	FORTH					
	case study	Athens					
Variable	type	Method	Equipment	starting date	closing date	frequency	Notes
Land surface temperature	Passive RS	Satellite remote sensing: Surface emissivity extraction, precipitable water and aerosols estimation, long-wave radiative transfer.	Software: ERDAS Imagine; ATCOR; SBDART. Data: Landsat and ASTER images for Athens	Jan 2010	Dec 2010		Spatial resolution: 60 - 120 m. It can be done for any of the case studies if the respective satellite data and ground truthing is available.
Land surface radiance, reflectance and brightness temperature	Passive RS						
Vegetation	Passive RS	Satellite remote sensing:Vegetation Indices; Fractional vegetation cover; Subpixel classification; Context-based classification.	Software: ERDAS Imagine; ENVI; Feature Analyst. Data: Landsat, SPOT, ASTER and Ikonos images for Athens	Jan 2010	Dec 2010		Spatial resolution: 1-30 m. It can be done for any of the case studies if the respective satellite data and ground truthing is available.
Topography	Passive RS	3D SURFACE CHARACTERISTICS. Satellite remote sensing: Phtotogrammetric analysis (DEM); GIS analysis (Slope, aspect, curvatures, watershed analysis).	Software: ERDAS Imagine; PCI Geomatics; SILCAST; ArcGIS. Data: ASTER images for Athens	Dec 2009	Dec 2009		Spatial resolution: 15 m. It can be done for any of the case studies if ASTER data are available.
Sensible Heat Flux	Active RS						
Surface Emissivity	Active RS						

Table 3. KCL.

	participant	King's College London United Kingdom					
	acronym	KCL					
	case study	London					
Variable	**type**	**Method**	**Equipment**	**starting date**	**closing date**	**frequency**	**Notes**
Land surface temperature	Passive RS	Satellite Remote Sensing	LandSAF land surface temperature (LST) product	all data relative to our observations will be analysed	Data download will continue after the end of the project	15 min	Spatial resolution: 60 - 120 m. It can be done for any of the case studies if the respective satellite data and ground truthing is available.
Land surface radiance, reflectance and brightness temperature	Passive RS	Satellite Remote Sensing; Airborne and LiDAR	Meteosat satellite data	RS flights dates are dependent on weather	LiDAR data will continue after the end of the project	15 min	
Vegetation	Passive RS						Spatial resolution: 1-30 m. It can be done for any of the case studies if the respective satellite data and ground truthing is available.
Topography	Passive RS						Spatial resolution: 15 m. It can be done for any of the case studies if ASTER data are available.
Sensible Heat Flux	Active RS	Satellite Remote Sensing, GIS and Meteorological data. Sensible heat flux calculation based on different modelling approaches (Aerodynamic Roughness Method, LUMPS)		all data relative to our observations will be analysed	Data download will continue after the end of the project		
Surface Emissivity	Active RS						

Table 4. CNR.

	participant	**Consiglio Nazionale delle Ricerce**					
	acronym	**CNR**					
	case study	**Firenze**					
Variable	**type**	**Method**	**Equipment**	**starting date**	**closing date**	**frequency**	**Notes**
Land surface temperature	Passive RS	airborne acquired images	FLIR M-40	giu-10		campaign	airborne acquired images
Land surface radiance, reflectance and brightness temperature	Passive RS	airborne acquired images	Geospatial Systems MS4100 CIR multispectral camera	giu-10		campaign	airborne acquired images
Vegetation	Passive RS						
Topography	Passive RS						
Sensible Heat Flux	Active RS						
Surface Emissivity	Active RS						

Table 5. NKUA.

	participant	National and Kapodistrian University of Athens					
	acronym	NKUA					
	case study	Athens					
Variable	**type**	**Method**	**Equipment**	**starting date**	**closing date**	**frequency**	**Notes**
Land surface temperature	Passive RS	Satellite Remote Sensing	Landsat TM/ETM+, ASTER LST	satellite images are acquired at periods or days that observation is needed	satellite images are acquired at periods or days that observation is needed	depends on the temporal resolution of the sensor: for TM, ETM+, ASTER: 16 days	
Land surface radiance, reflectance and brightness temperature	Passive RS	Satellite Remote Sensing	Landsat TM/ETM+, ASTER LST	satellite images are acquired at periods or days that observation is needed	satellite images are acquired at periods or days that observation is needed	depends on the temporal resolution of the sensor: for TM, ETM+, ASTER: 16 days	
Vegetation	Passive RS	Satellite Remote Sensing	Landsat TM/ETM+, ASTER LST	satellite images are acquired at periods or days that observation is needed	satellite images are acquired at periods or days that observation is needed	depends on the temporal resolution of the sensor: for TM, ETM+, ASTER: 16 days	Vegetation indices
Topography	Passive RS	surface slope, surface aspect, digital elevation model (DEM)	ASTER data	satellite images are acquired at periods or days that observation is needed	satellite images are acquired at periods or days that observation is needed	depends on the temporal resolution of the sensor: for TM, ETM+, ASTER: 16 days	
Sensible Heat Flux	Active RS						
Surface Emissivity	Active RS						

Table 6. CMCC.

	participant	Centro Euro-Mediterraneo per i Cambiamenti Climatici					
	acronym	CMCC					
	case study	Firenze					
Variable	**type**	**Method**	**Equipment**	**starting date**	**closing date**	**frequency**	**Notes**
Land surface temperature	Passive RS						
Land surface radiance, reflectance and brightness temperature	Passive RS						
Vegetation	Passive RS						
Topography	Passive RS						
Sensible Heat Flux	Active RS	modelling	ACASA model for flux simulation	set-09	giu-11		Initial conditions from in situ measurements; 30-min average; units: W m^{-2}
Surface Emissivity	Active RS	modelling	ACASA model for flux simulation	set-09	giu-11		Initial conditions from in situ measurements; 30-min average

Table 7. SOTON.

	participant	University of Southampton					
	acronym	SOTON					
	case study	London					
Variable	**type**	**Method**	**Equipment**	**starting date**	**closing date**	**frequency**	**Notes**
Land surface temperature	Passive RS						
Land surface radiance, reflectance and brightness temperature	Passive RS						
Vegetation	Passive RS	Use the following existing data sets: (i) Landcover 2000 (CEH), (ii) Trees in Towns II (Britt & Johnson 2008) and (iii) Chainsaw massacre (GLA, 2007) to estimate canopy cover type areas for GLA.		feb-09	ott-10		
Topography	Passive RS						
Sensible Heat Flux	Active RS						
Surface Emissivity	Active RS						