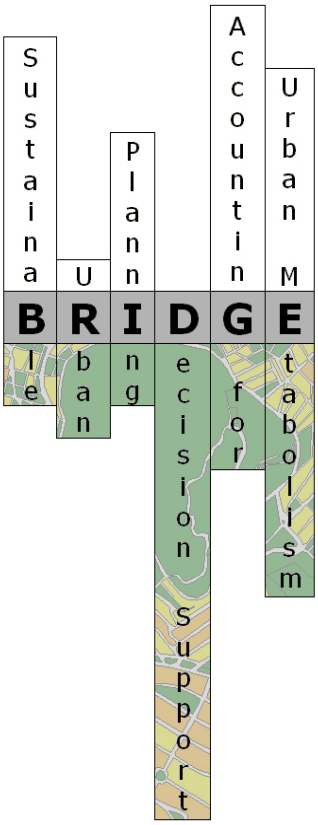
SEVENTH FRAMEWORK PROGRAMME
THEME 6: Environment (including climate change)

Contract for: **Collaborative Project**

D.3.1.1
Datasets of air quality, energy, water, carbon and pollutants fluxes/concentrations



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0.1	Oct 16/09	V. Magliulo (CNR ISAFOM)	Including contributions from CMCC and UHEL
0.2	Oct 30/09	V. Magliulo (CNR ISAFOM)	Further contributions from CMCC and UHEL; SOTON sections added; CNR-IBIMET; KCL, IETU, NKUA still missing
0.2	Nov 11/09	V. Magliulo (CNR ISAFOM)	KCL description added Include Links to KCL data structure and CNR-IBIMET background info for Firenze
0.3	Nov 20/09	V. Magliulo (CNR ISAFOM)	Updates from case studied included. Format according to BRIDGE Deliverable templates Description and info concerning Athens case study missing
0.4	Nov 24/09	V. Magliulo (CNR ISAFOM)	Description and info concerning Athens case study included. Modifications from UBAS, IETU, CMCC, UHEL, CNR, SOTON
1.0	Nov 30/ 09	V. Magliulo (CNR ISAFOM)	Final draft. Table with measurement details and methodologies added in Annex

Table of Contents

1. Introduction

Urban communities consume material and energy and eliminate the wastes from the process. Energy and mass are exchanged by urban environments and fluxes are modulated by human activities, such as heating and air conditioning, vehicular traffic, changes in vegetative cover, waste production etc., in what has been termed "**urban metabolism**".

BRIDGE WP3 includes the Data Collection and Analysis activities in BRIDGE case studies, representing a unique attempt to collect and to analyse an integrated database suitable for the development and validation of models and methodologies for the analysis of fluxes between the city and its environment.

Task 3.1 – *in situ* data collection and analysis - applies established and newly developed methodologies aimed at collecting comprehensive data sets by means of in situ observations.

Specific objectives are the collection of meteorological data, trace gas emissions, mass, energy, and particle fluxes; assess the role and impact of city vegetation; identify the increase of the energy demand of buildings for cooling purposes; document the sensible heat flux and heat island characteristics of medium and large selected European cities.

1.1 Purpose of the document

Task 3.1 is aimed at monitoring the main fluxes, using in-situ observations, in the five BRIDGE case studies of Helsinki, Athens, London, Firenze and Gliwice. These cities were selected as European cities representative of different climates, sizes and socio-economic conditions and will be investigated for the above described drivers and flows.

The following paragraphs will provide an overview of ongoing measurement work in the different case studies. Details concerning methods and instrumentation used and expected starting and closing date are provided in Annex.

An exhaustive report of methodologies and protocols adopted is to be provided in D.3.4 “BRIDGE observations report” and D.3.5 ”BRIDGE observations protocol” due in month 30.

The BRIDGE Consortium decided that developing a project database hosting all data collected was unnecessary and hard to realize, due to the heterogeneity of information collected, in terms of time steps, structure of records etc Moreover, it was pointed out that proper data exploitation could not be achieved without direct interaction between data providers on one side and modellers and DSS developers on the other.

Data sets were therefore not uploaded on the BRIDGE ftp Server, but will rather be obtained directly by providing institutions, however the location of the data is given in this report.

Contact details for data download are reported for each case study in the following sections.

1.3 Definitions and Acronyms

Acronyms

CoP	Community of Practice
DSS	Decision Support System
CNR	Consiglio Nazionale delle Ricerche, Italy
KCL	King's College London
NKUA	National and Kapodistrian University of Athens
UHEL	University of Helsinki, Finland
IETU	Instytut Ekologii Terenów Uprzemysłowionych, Poland
CMCC	Centro Euro-Mediterraneo per i Cambiamenti Climatici, Italy
UBAS	University of Basel

1.4 Document References

Adamo, P., Crisafulli, P., Giordano, S., Minganti, V., Modenesi, P., Monaci, F., Pittao, E., Tretiach, M., Bargagli, R., 2007. Lichen and moss bags as monitoring devices in urban areas. Part II: Trace element content in living and dead biomonitors and comparison with synthetic materials. Environmental Pollution 146 (2) 392-399.

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Tretiach, M., Adamo, P., Bargagli, R., Baruffo, L., Carletti, L., Crisafulli, P., Giordano, S., Modenesi, P., Orlando, S., Pittao, E., 2007. Lichen and moss bags as monitoring devices in urban areas. Part I: Influence of exposure on sample vitality. Environmental Pollution 146 (2) 380-391.

1.5 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 3.1 is aimed at monitoring the main fluxes, using in-situ observations, in the five BRIDGE case studies of Helsinki, Athens, London, Firenze and Gliwice. These cities were selected as European cities representative of different climates, sizes and socio-economic conditions and will be investigated for the above described drivers and flows.

The following data will be provided:

- Time series and spatially extensive data sets of air quality and surface fluxes by participants KCL, CNR, IETU, UHEL, NKUA, CMCC.
- Turbulent fluxes and distribution of trace gas and particle concentrations by participants CNR, IETU, UHEL, SOTON, CMCC.
- Gas exchange of urban vegetation in relation to soil properties, by participants SOTON, CNR.
- Urban heat island characteristics and energy demand of buildings for cooling, by participants NKUA, IETU, CNR.
- Indoor environmental quality, by participants NKUA, CMCC.

An overview is given of ongoing measurement work in the different case studies. Details concerning methods and instrumentation used and expected starting and closing date are provided in Annex

Contact details for data download are also provided

2.1 Partners involved

1. **CNR** Consiglio Nazionale delle Ricerche, Italy
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2. **KCL** King's College London
   Sue Grimmond (sue.grimmond@kcl.ac.uk): London case study leader
3. **NKUA** National and Kapodistrian University of Athens
   Mattheos Santamouris (msantam@phys.uoa.gr): Athens case study leader
4. **UHEL** University of Helsinki, Finland
   Timo Vesala (timo.vesala@helsinki.fi): Helsinki case study leader
   Annika Nordbo (annika.nordbo@helsinki.fi): Data management contact person
5. **IETU** Instytut Ekologii Terenów Uprzemysłowionych, Poland
   Tomasz Staszewski (stasz@ietu.katowice.pl): Gliwice case study leader
6. **CMCC** Centro Euro-Mediterraneo per i Cambiamenti Climatici, Italy
   Donatella Spano (spano@uniss.it)
   Serena Marras (serenam@uniss.it)

2. Case Studies

3.1 Helsinki

Description of study sites

Most of the measurements made under Task 3.1 are carried out at the urban measurement station SMEAR III. Measurements are carried out in two locations, Kumpula and Viikki, in Helsinki.

The air quality and meteorological measurements are made at the Kumpula site (60°12´N, 24°57'E, 26 meters above sea level), which is located at the University of Helsinki campus area about five kilometers from the Helsinki city centre. Measurements are carried out in a 31 meters high triangular lattice tower, which is equipped with meteorological instrumentation at several heights.

The surroundings in Kumpula are heterogeneous consisting of buildings, paved areas and vegetation, and three distinct areas of land use have been recognized in different wind directions. In direction 320-40°, lays the urban sector with high fraction of building with mean height of 20 meters and paved areas. One of the main road leading to the Helsinki city centre with 45 000 vehicles per workdays passes the road sector (40-180°) with a distance of 150 meters from the measurement tower. The area between is covered with deciduous forest. The vegetation sector is located in direction 180-320°, where the University Botanical garden and an allotment garden are located

The multidisciplinary urban ecosystem and tree research lies in Viikki, seven kilometers from the Helsinki city centre. Viikki area consists of the University campus area, new residential areas build since early 2000's and extensive green areas. The measurements are done on two streets with south –west north-east direction. The streets are paved with local pillar type black alder and lime trees growing there. The streets have been build in 2002 using normal construction techniques, one street in normal modern residential area and one in an office area. Three different urban load bearing soil mixtures currently used in Helsinki are tested at the sites.

Collected data

Kumpula: Measurements include radiation components and profiles of the temperature and wind. The fluxes of momentum, sensible heat, water vapor, carbon dioxide and aerosol particle number are measured with the eddy covariance technique on top of the tower. Next to the tower is situated an air conditioned container where aerosol particle and gas concentration instrumentation is located. The weather station is situated on the roof of one of the University of Helsinki buildings.

Vikki: Urban tree measurements cover campaignwise photosynthesis and transpiration measurements by chambers, continuous transpiration measurement with sapflow needles, stem diameters, soil temperature and humidity, soil CO_2 concentration, photosynthetically active radiation and basic meteorological quantities. In addition to the measurements carried out at the SMEAR III station, stormwater quantity and quality are planned to be measured in three small catchments in Helsinki area.

Contact info:

For further details:
http://www.atm.helsinki.fi/SMEAR/
E-mail: annika.nordbo@helsinki.fi

3.2 Athens

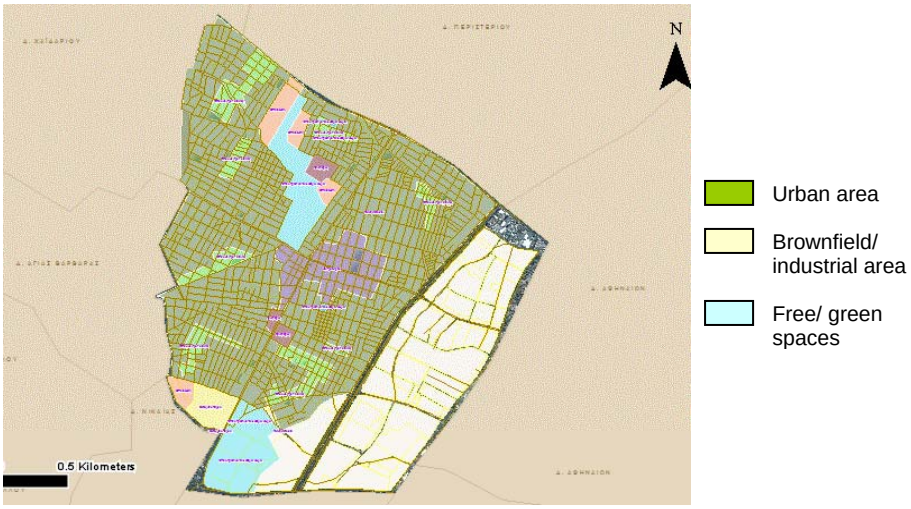
Description of study sites

The Athens Case Study is focused on the municipality of Egaleo, which lies in Western part of Athens.

A B

Egaleo in the greater Athens area (A). The case study site (B) [Source: Google Earth]

Five main road axes divide the area in four quarters. One of the quarters is an industrial degraded area (brownfield) called Eleonas. The total area of Egaleo is 650 ha and it is flat in general. The population is 74.046, although it is estimated that at least 120000 people, mostly medium and low income, live and work in the area. The average density is estimated to be 225 inhabitants/ha. According to onsite observations and research it was found that most of the buildings in the area were built between 1950's – 1980's, with several of them built around 1950s. These buildings are made of reinforced concrete, and have one to three floors height. A small amount of houses were built in the 1920's and onwards. These residences are made of stone and are in poor condition. Finally, there are buildings built in the last decades made of reinforced concrete reaching a height of up to 6 floors. As it appears in the land use map of Egaleo, there very little free/ green spaces.



Land use map of Egaleo [Source: www.aigaleo.gr]

Egaleo is considered an environmentally degraded area facing problems with:

- air pollution
- traffic and transport
- thermal discomfort
- lack of green/ free spaces
- poor quality of building stock
- energy

The in situ measurements that have been carried out focus on the area of Egaleo. Additionally NKUA is providing meteorological data from the National Observatory of Athens station "Thission" which is close to the case study area.

Collected data:

The following data have been collected and are available on the BRIDGE ftp server (http://ftp.iacm.forth.gr/egroupware/).

A. Meteorological parameters from "Thission" station

The folder "Meteo data Thission.rar" contains the following meteorological parameters:

1. Air temperature (C)
2. Relative humidity (%)
3. Wind direction and wind speed (m/s)
4. Precipitation (mm)
5. Diffuse solar radiation (W/m2)
6. Total solar radiation (W/m2)
7. Sunshine duration (hours)

These data were taken from Thission meteorological station from the National Observatory of Athens, which is located near Egaleo, the Athens case study area. The data cover the whole year for 2008 until October 2009

B. In situ experimental measurements

Another category of measurements are those that have been carried out at the case study area (Egaleo) during summer 2009. The following experiments have been carried out:

1. Indoor measurements

Ten residential buildings have been selected at the case study area and were monitored during the summer of 2009. Information on the selected buildings has also been collected (plans, energy consumption data etc.). Temperature and relative humidity sensors have been installed in the selected buildings. Additionally, 320 questionnaires-ASHRAE std 55(long and short) have been collected from the residents and they are currently being analysed.

1.1. The file called 'indoortemperatures' contains the recorded internal temperatures of 10 residential buildings recorded from a logger which has been placed in urban open air station. (Units: °C, Log Interval (mm:ss): 10:00). The duration of the measurements depends on the residential building.

1.2. The file called 'indoorPMdata' contains data of the recorded particulate matter -PM1, PM2.5, PM10 -values of each residential building. (units: mg/m³)

1.3 The file called ' RadiantTemp_ AirTemp_Humidity_AirVelocity' contains data for air temperature (C), humidity (%), Air velocity (m/s) and Radiant temperature (C) for each residential building for one experiment day.

2. *Outdoor measurements*

It contains data performed at the case study area to monitor the outdoor environmental conditions.

2.1. The file called 'cup anemometer_data' contains raw data recorded from the cup anemometer which has been placed on the top of the canyon in our area of investigation. It measures the wind speed (m/s) and direction out of the canyon.

2.2. The file called '3axis anemometer_data' contains raw data recorded from the 3xis anemometers which have been placed near to the facades of the canyon(dist:1.5m from the wall). They measure the three components of the wind speed-x,y,z.

2.3. The file 'PM_measurements' contains files which include data of the recorded particulate matter -PM1, PM2.5, PM10 -values for one experimental day (12th June 2009). (Units: mg/m³)

2.4. The file 'TEMP_AIRSPEED_AIRVELOCITY_4levels' contains data of four wind speed and four direction anemometers that have been placed in three different heights-3.5, 7.5, 15.5m – in the antenna of NKUA's mobile station, for one experimental day 12th June 2009.

2.5. The file 'radianttemp_airvelocity_airtemp_humidity_1.5m' contains a file which includes data of air temperature (C), humidity (%), Air velocity (m/s) and Radiant temperature (C) at the height of 1.5m, for one experimental day 12th June 2009.

3. *Spatial Outdoor measurements*

The file contains data for one experimental day (15th June 2009). It includes measurements of the temperature by a thermometer T351-PX 1/3 DIN (on 1.5mheight) placed in the antenna of the mobile station. The measurements were taken at different spots throughout the area as indicated in column C (street names where the measurements where performed. (Units: ° C)

C. Air quality measurements

The files contain data on air pollutants (CO, NO_2, NO, SO_2, O_3) on several stations close to the case study area. Hourly values for a whole year period are given. The data are provided by the Ministry of Environment, Energy and Climate change.

D. Heat island measurements

The file contains air temperature data from Egaleo and air temperature data from a reference station in a suburban area in order to calculate the heat island effect throughout the experimental period.

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3.3 London

Description of study sites

Physical Meteorology is collected at two sites on the KCL Strand campus: KSK (King's Strand King's) and KSS (King's Strand). The main site is KSS which became operational 1 November 2009

Collected data:

1. Physical Meteorological variables and CO_2 are measured (see accompanying spreadsheet). Measurements are collected at 10 Hz and analysed into 15, 30 and 60 min periods. More details are provided at:

http://geography.kcl.ac.uk/micromet/index.htm

or

http://geography.kcl.ac.uk/micromet/Bridge/bridge.html

Air quality data are collected around London. More details are provided at
http://geography.kcl.ac.uk/micromet/Bridge/bridge.html or
http://www.londonair.org.uk/london/asp/default.asp

The data are available at 15 min time intervals. File format are at:

http://geography.kcl.ac.uk/micromet/Troubleshoot/Instrument_Overview.htm

Beyond the observed data, extensive data analysis and modelling activities are underway. Most notably for anthropogenic heat flux.

For further details:

http://geography.kcl.ac.uk/micromet/index.htm
http://geography.kcl.ac.uk/micromet/Bridge/bridge.html
http://geography.kcl.ac.uk/micromet/Troubleshoot/Instrument_Overview.htm

2. 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 from the CEH Landcover 2000 data 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.

Mean seasonal [PM10] data for 2006 has been extracted from the 20 m resolution London Atmospheric Emissions Inventory (LAEI 2006) for each borough. Using a buffer (~20 m) and a road network overlay the mean [PM10] associated with roads (street tree environment) is currently being established for selected boroughs.

Modelled [PM10] (LAEI 2006) has been used to extract [PM10] for each London borough

Urban green space capture of PM10 will be estimated for the following scenarios using the UFORE model approach:

- Borough level annual mean capture of PM10 by (i) blocks of green space (ii) street tree canopy cover.
- Selected borough level mean capture of PM10 by (i) blocks of green space (ii) street tree capture using mean of [PM10] extracted from the 20 m buffer around the roads (using literature derived deposition velocities to street trees).

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air quality info and data can be found at:
http://www.londonair.org.uk/london/asp/default.asp

sites locations details are found at:

http://geography.kcl.ac.uk/micromet/index.htm
Username: monitoring
Passwd: sg5035

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3.4 Firenze

Description of study sites

An eddy covariance (EC) flux station was installed in Firenze (43° 47' N, 11° 15' E) in September of 2005 at the Osservatorio Ximeniano, in the center of the city and is operating from 14 September 2005. Air quality datasets for a network of 5 air quality monitoring stations (placed in urban road and rural area) are available from 1 January 2003.

Collected data:

1) A new instrumentation, the EOLO (Eddy cOvariance-based upLift Observation system) will be used to collect turbulent fluxes of dust in the Firenze case study. Size-segregated fluxes of mineral dust particles with aerodynamic diameters between 0.35 and 9.50μm are measured with this system. The system covers the largest portion of mineral dust mass subject to long range transport. The system is comprised of two main components: the wind system and the concentration system. The wind system consisted of an ultrasonic anemometer Metek USA-1, (Metek GmbH, Elmshorn, Germany), allowing fast and accurate measurements of the 3-D wind velocity and sonic temperature; this last parameter also provides a good estimation of the air temperature. The concentration system includes several parts. The most important are the OPC (CI-3100 series, Climet Instruments Co., Redlands, CA, USA) and the Multi-Channel Analyzers (MCA8000, Amptek Inc., Bedford, MA, USA). To minimize uncertainties, the inlet of the measuring system is directly attached to the anemometer. In our design, sampled particles are split in two channels: the so-called finer channel (Dopt from 0.26 to 0.54μm) and the coarser channel (Dopt from 0.54 to 7.00μm). The system simultaneously acquires data from the two channels through dedicated MCA devices. "Finer" and "coarser" particle number concentrations are stored every 30 min. An acquisition frequency of 5Hz is selected. The system is able to simultaneously record counts of particles falling in 18 size ranges. The number of particles per unit of sampled volume (number concentration) is than obtained.

2) ACASA (Advanced-Canopy- Atmosphere-Soil Algorithm) is a sophisticated model for estimating energy and mass fluxes between the surface and the atmosphere. ACASA was recently modified to simulate energy and mass fluxes in urban environment. It treats the surface and associated fluxes as an interconnected system, and the atmosphere, the urban surface and the soil are represented as a multilayer system. The model incorporates third-order closure principles for turbulent statistics to predict the effects that higher-order turbulent kinetic and thermodynamic processes have on the surface microenvironment and associated fluxes of heat, moisture, momentum, and carbon. Differently from other models, it allows counter-gradient transport that simpler models are unable to describe. The ACASA domain extends maximally to 100 m above the city and plant canopy elements to ensure applicability of the turbulence assumptions. Meteorological input data are taken from Eddy Covariance measurements collected in Firenze by CNR. ACASA will produce simulated fluxes, at half-hourly time step, of Net Radiation, Sensible and Latent Heat flux and Carbon dioxide turbulent flux

3) Physical Meteorological variables and turbulent fluxes are measured. A mast of 3 m was mounted on a typical tile roof of an ancient building of the Ximenian observatory at 33 m above the street level. Turbulent fluxes of CO_2, momentum, and sensible heat were collected using a sonic anemometer (Young/Metek) and an open-path CO_2/H_2O infrared gad analyzer (IRGA; Li-Cor 7500). The distance between the two sensors was approximatively 0.4 m. The IRGA is calibrated every month using

reference gas tanks and a portable dewpoint generator (Li-Cor 610). Raw data are collected at the frequency of 20 Hz. Half-hourly fluxes are derived. The weather station is situated on the same roof and data are available from 1 January 2005. 2BTECH 202 UV monitor for O_3 concentration was installed and data are available from 15 October 2009. Air quality data comprises Ozone (TwoBtech 202 UV analyzer) and CO (UNITEC ETL2000 thcik film sensor) concentration.

Air quality datasets are available for FTP download. This data set contains PM10-PM2.5 (daily mean) and SO_2-NO_2-CO (hourly mean - solar time) for a network of 5 air quality monitoring stations. A map of air quality monitoring station is available in kmz (google earth) format.

An innovative microjoule lidar developed in cooperation with ENEA, will provide measurements of horizontal and vertical profiles of dust as well as the height of the planetary boundary layer. The Lidar has been designed to be a low-cost and an ultralow consumption instrument, suitable for airborne measurements. A GRIMM aerosolspectometer, capable of analysing the distribution of dust particles in 20 spectral bands in the range between 0.23 μm to 20 μm, will complement remote observations of the Lidar with detailed *in situ* information on the nature of dust.

Data will be available starting in January 2010, and airborne and street lidar campaigns are being planned for the spring of 2010.

4) Biomonitoring of airborne trace metals will be made using moss bags technique. The moss Hypnum cupressiforme will be used as a bioindicator for the estimation of atmospheric traces metal deposition in the urban area of Firenze.

Moss carpet will be collected from the tree in a forest of central Sardinia (municipality of Bolotana – Nuoro) with absence of air pollution.

In laboratory, the moss plant will be cleaned from particles of soil, dead material and attached litter and will be submitted to seven consecutive washings with distillated water. After cleaning samples will be air dried. Moss bags will be prepared by weighing out 2 g air-dried weight, and packing it loosely in nylon nets of 12 x 12 cm with mesh of 4 mm^2.

In the urban area of Firenze, two moss bags will be located in three air pollution monitoring station for six weeks during winter spring and summer seasons. Two moss bags, used as control, will not be exposed.

Following exposure the moss samples will be removed from the nylon net and dried for 48 h at 40 °C in a forced air-oven, and the samples will be then homogenized in agata mills. For the analysis, about 0.5 g of homogenized moss tissue will be digest in a microwave oven with 10 ml of concentrated nitric acid after adding 1 ml of H_2O_2. Digest will be analyzed for As, Cr, Cu, Fe, Ni, Pb, V, and Zn by Inductively Coupled Plasma Atomic Emission Spectrometry. To check sample homogeneity and uncertainties related to mineralization and analysis of samples, replicate determinations were performed. Element concentration will be determined by the method of standard additions and will be expressed in micrograms per gram on a dry basis.

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3.5 Gliwice

Description of study sites

Gliwice Monitoring Station, part of the Silesian Air Monitoring Network, is located 1 km from the Academic District (Politechnika). An eddy covariance (EC) flux station was installed in Gliwice (50°16'45'' N, 18°39'20'' E) in December of 2009 on the flat roof of a 15 m high building close to the Gliwice Monitoring Station. The source area in easterly directions is dominated by urban area, while towards westerly directions rural areas prevail.

Collected data:

Air pollution: SO_2, NO, NO_2, O_3, PM10

Meteo parameters: wind direction and velocity, air temperature, realtive humidity, total radiation, atmospheric pressure, precipitation.

Additional measurements using the IETU equipment which can complete UBAS mast installed in the Politechnika District may be taken out:

Particle number Equipment: (Particle counter (Profiler P212 –Met One) 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 7.5, 10.0 µm

PM10 concentration (or PM2.5) Equipment: Particulate Monitor, Model 5030 SHARP,

Soil moisture and temperature profiles 4 depths.

Turbulent flux measurements will be performed by UBAS starting from January 2010:

Variable	Frequency	Method	Equipment
The wind components (u,v, w)	10Hz	online	YOUNG 81000
Particle number	1Hz	Online (>0°C)	Particle counter (Profiler P212 –Met One) 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 7.5, 10.0 □m
PM10 concentration (or PM2.5)	1/h	online	Particulate Monitor, Model 5030 SHARP
Air humidity		online	
Air temperature		online	
Soil moisture profile4 depths		online	
Soil temperature profile 4 depths		online	
Meteorological Mast 10 m		online	
Eddycovaraince system			Logger CR1000
Wind vector	10 Hz		Young 81000 or Campbell CSAT3
Conc. of H_2O and CO_2	10 Hz		LiCor LI7500
Air Temp. and humidity	1 min		Vaisala HMP45
Components of net radiation	1 min		Kipp & Zonen CNR1

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Measurements averaged every 30 min/1hour are available on-line at: http://stacje.katowice.pios.gov.pl/iseo/

Annex:

Measurement details for the 5 case studies

Case study: Athens							
participant		National and Kapodistrian University of Athens Greece					
acronym		NKUA					
category	**Variable**	**Method**	**Equipment**	**Notes**	**starting date**	**closing date**	**frequency**
air quality	**H_2O and CO_2 concentrations**	On line /sampling	TSI IAQ-CALC		June 09	Sep 10	10'
air quality	**NO_x concentration**	Chemiluminescent gas analyzer	Thermo Electron Corporation model 42i	outdoor measurements	June 10	Sep 11	10'
air quality	**O_3 concentration**	UV Photometric technology	Thermo Electron Corporation model 49i	outdoor measurements	June 11	Sep 12	10'
air quality	**Particle number size distribution**	online and sampling	Model 8520 DUSTTRAKTM Aerosol Monitor/ SKC	indoor and outdoor measurements	June 11	Sep 12	10'
air quality	**Principal outdoor pollutants (VOCs, contaminants, etc)**	gas chromatography	PPB RAE+VARIAN CP-3800 Gas Chromatograph/GCMS System+Innova Airtech 1303(potentially)		June 12	Sep 13	10'
air quality	**SO_2 concentration**	Pulsed fluorescence gas analyzer	Thermo Electron Corporation model 43i	outdoor measurements	June 13	Sep 14	10'
IAQ	**CO_2 concentration**	online and sampling	TSI IAQ-CALC	indoor measurements	June 09	Sep 10	10'
IAQ	**Air flow measurements**	Tracer gas	INNOVA AIR TECH - Photoacoustic Field Gas-Monitor 1312	indoor measurements	June 10	Sep 11	once in specified conditions
IAQ	**Air infiltration**	Blower door	Infiltec E3-A-DM4 Blower Door	indoor measurements	June 11	Sep 12	once in specified conditions
IAQ	**PM1, PM2.5, PM10**	online and sampling	Model 8520 DUSTTRAKTM Aerosol Monitor/ SKC	indoor measurements	June 09	Sep 10	10'
IAQ	**Principal indoor pollutants (NOx, VOCs, etc)**		Tracer Gas Acquisition system(Analyzer) Innova Airtech 1303+VARIAN CP-3800 Gas Chromatograph/GCMS System	indoor measurements	June 09	Sep 10	10'
IAQ/ thermal comfort	**Thermal comfort parameters (e.g. Air temperature (wet and dry bulb), air**	Online	Tiny Tag temperature logger- Gemini Data Loggers + Delta OHMH/D230.70RTD Thermometer+Dantec low velocity flow analyser	indoor measurements	June 10	Sep 11	10'

	velocity, HR, black globe T)		+ Thermal Comfort Datalogger - INNOVA 1221(potentially)				
meteo	**Air pressure**	Online	meteo data provided by the National Observatory of Athens		June 11	Sep 12	hourly values
meteo	**Air temperature**	online-sampling	Tiny Tag temperature logger- Gemini Data Loggers+Therm T351-PX 1/3 DIN	Outdoor +inside the main canyon in the center of each canyon at different heights on the antenna of the mobile meteorological station	June 12	Sep 13	15'/ hourly values
meteo	**Precipitation**	Online	meteo data provided by the National Observatory of Athens		June 11	Sep 12	hourly values
meteo	**Relative Humidity**	Online	Tiny Tag temperature logger- Gemini Data Loggers		June 12	Sep 13	15'/ hourly values
meteo	**Surface Temperature**	infrared thermography	AGEMA Thermovision 570 + Cole –Palmer 08406				as reqested
micromet	**All three wind components (u,v and w)**	Online	Young Model 81000 3-axis Ultrasonic anemometer (potentially)/or R M Young Company 27005T UVW ANEMOMETER	inside the main canyons near the facades of the canyon.	June 12	Sep 13	1 Hz
micromet	**wind speed and direction**	Online	A100K Pulse output Anemometer/ Anemometers W200 Porton Windwane, ±300°range / 12102 gill 3cup anemometer	inside the main canyons in the center of each canyon at different heights in the antenna of the mobile meteorological station			1 Hz
Visual comfort	**Light distribution**	On line	Tes 1335 Light Meter	indoor measurements	June 12	Sep 13	as requested

Case study: Firenze							
participant		**Consiglio Nazionale delle Ricerche**					
acronym		**CNR**					
category	***Variable***	***Method***	***Equipment***	***Notes***	***starting date***	***closing date***	***frequency***
air quality	**H_2O and CO_2 concentrations**	online	Open-path infrared gas analyzer (LI-7500)	Two towers	ongoing	end of BRIDGE project	10 Hz - 30' average
air quality	**NO_x concentration**	online	thick film sensors UNITEC ETL2000	also measures CO	set-09	lug-11	hourly
air quality	**O_3 concentration**	online	2BTECH 202 UV monitor		set-09	lug-11	hourly
air quality	**Particle number size distribution**	Lidar and particle counter	micro-Lidar Embedded devices; GRIMM 1109 partcile counter	PBL profiles via Lidar; in situ size distribution by particle counter	dic-09	lug-11	hourly - campaigns
air quality	**Principal outdoor pollutants (VOCs, contaminants, etc)**	Bioaccumulation campaigns & lab spectrometry	"moss bags" & coupled plasma-atomic emission spectrometer (ICP-AES)		gen-10	lug-11	seasonal - campaigns
IAQ	**PM1, PM2.5, PM10**	online		5 air quality monitoring stations	Jan 03	end of BRIDGE project	daily
IAQ	**Principal indoor pollutants (NOx, VOCs, etc)**	online		5 air quality monitoring stations	Jan 03	end of BRIDGE project	hourly
meteo	**Air pressure**	online	Digital barometer		Jan 05	end of BRIDGE project	hourly
meteo	**Air temperature**	online	Thermistors + Sonic T		Jan 05	end of BRIDGE project	hourly
meteo	**Precipitation**	online	Precipitation collectors		Jan 05	end of BRIDGE project	hourly
meteo	**Surface Temperature**	online	Thermistors	For the green area, only	ongoing	end of BRIDGE project	hourly
micromet	**All three wind components (u,v and w)**	online	Metek USA-1	Two towers	ongoing	end of BRIDGE project	10 Hz - 30' average

micromet	**Friction velocity, Sensible and latent heat fluxes and CO_2 flux**	Eddy covariance	Metek USA-1 + Open/Closed-path infrared gas analyzer (LI-7500/LI-7000)	Two towers	ongoing	end of BRIDGE project	10 Hz - 30' average
plant	**Diurnal stem and bark diameter variation (6 trees)**	online	Delta-T Devices Ltd, QS2	From 2 streets	ongoing	end of BRIDGE project	hourly
radiation	**Up- and downward long- and short wave radiations + PAR**	online	Net radiometer and photodiode sensor (Kipp&Zonen, CNR1 + PAR Lite)		ongoing	end of BRIDGE project	hourly
radiation	**UVA & UVB radiation**	Twin differential mobility parameter	Hauke-type DMA (10.9 cm) +CPC (TSI3025), Hauke-type DMA (28 cm) +CPC (TSI3010)		ongoing	end of BRIDGE project	hourly
		Centro Euro-Mediterraneo per i Cambiamenti Climatici					
		CMCC					
air quality	**H_2O and CO_2 concentrations**	online	Open-path infrared gas analyzer (LI-7500);ACASA model for flux simulation	Istantaneous and 30-min average (optional, not mandatory for DiSAFRi); units: CO2 in mmol mol-1 H2O in mmol mol-1 file format: ASCII, comma-separated values	nov-09	giu-11	10Hz and 30' average
air quality	**Particle number flux (starting from 0.32 nm)**	EC	Gill WindMaster + Optical Particle Counter (Climet CI-3100)	30-min average. approx. aerodyn. diameter ranges: ≈ 0.32-1.00 μm ≈ 0.32-2.50 μm ≈ 0.32-10.0 μm units: particle number fluxes: # cm-2s-1 particle number concentration: # cm-3 file format: ASCII, comma-separated values	feb-10	giu-11	30'

air quality	**Particle number size distribution**	post-processing of optical counting	custom particle sampling equipment	1-min average (customizable). Optical diameter range: 0.30 - 7.00 μm 17 size bins in this range units: particle number concentrations: # cm-3 (normalized by dLn(D) also available)	feb-10	giu-11	30'
micromet	**All three wind components (u,v and w)**	online	Gill WindMaster; ACASA model for flux simulation	Istantaneous and 30-min average; u,v,w: m s-1 file format: ASCII, comma-separated values	nov-09	giu-11	10Hz and 30' average
micromet	**Friction velocity, Sensible and latent heat fluxes and CO_2 flux**	Eddy covariance	Gill WindMaster + open-path infrared gas analyzer (LI-7500); ACASA model for flux simulation	30-min average; units: Friction velocity: m s-1 CO2 fluxes: mmol m-2 s-1 Latent/sensible heat fluxes: W m-2 file format: ASCII, comma-separated values	nov-09	giu-11	30'

Case study: Gliwice							
participant		University of Basel					
acronym		UBAS					
category	**Variable**	**Method**	**Equipment**	**Notes**	**starting date**	**closing date**	**frequency**
air quality	**H_2O and CO_2 concentrations**	Gas Analysis (open path)	Open-path infrared gas analyzer (LI-7500);		dic-09	dic-10	10Hz,30' average
air quality	**NO_x concentration**	on line	Silesian District Air Quality Network				
air quality	**O_3 concentration**	on line	Silesian District Air Quality Network				
air quality	**SO_2 concentration**		Silesian District Air Quality Network				
IAQ	**CO_2 concentration**	sampling	Infrared gas analyzer (LI-7500)		dic-09	dic-10	10 Hz
meteo	**Air pressure**	sampling	LI-7500		dic-09	dic-10	10 Hz
meteo	**Air temperature**	sampling	Vaisala HMP 45		dic-09	dic-10	1'
meteo	**air temperature (next to trees)**	online	Silesian District Air Quality Network				
meteo	**Precipitation**	online	Silesian District Air Quality Network				
meteo	**Relative Humidity**	sampling	Vaisala HMP 45		dic-09	dic-10	1'
meteo	**u, v components**	sampling	ultra-sonic anemometer Young 81000		dic-09	dic-10	10Hz,30' average
micromet	**All three wind components (u,v and w)**	sampling	ultra-sonic anemometer Young 81000		dic-09	dic-10	10Hz,30' average
micromet	**Friction velocity, Sensible and latent heat fluxes and CO_2 flux**	EC-Method	Young 81000 & LiCor 7500		dic-09	dic-10	10Hz,30' average
micromet	**wind speed and direction**	sampling	ultra-sonic anemometer Young 81000		dic-09	dic-10	10Hz,30' average
radiation	**Up- and downward long- and short wave radiations + PAR**	sampling	Kipp & Zonen CNR 1		dic-09	dic-10	1'
Weather station	**temp, rain, etc**	on line	Silesian District Air Quality Network				

Case study: Helsinki							
participant		University of Helsinki					
acronym		UHEL					
category	Variable	Method	Equipment	Notes	starting date	closing date	frequency
air quality	**H_2O and CO_2 concentrations**	online	Open/Closed-path infrared gas analyzer (LI-7500/LI-7000)		2005/12/3 / 2007/6/28	end of BRIDGE project	1 0 Hz, 30' average
air quality	**NO_x concentration**	Chemiluminescence technique	TEI42S	detection limit 0.2ppb	nov-05	end of BRIDGE project	60 s, 30' average
air quality	**O_3 concentration**	IR-absorption photometer	TEI49	detection limit 0.5ppb	nov-05	end of BRIDGE project	60 s, 30' average
air quality	**CO concentration**	Non-dispersive infrared absorption technicue	Horiba APMA 370	detection limit 20ppb	nov-05	end of BRIDGE project	60s
air quality	**Particle number flux (starting from 0.32 nm)**						
air quality	**Particle number flux (starting from 6 nm)**	EC	Metek USA-1 + Water-based Condensation particle counter (TSI-3781)		lug-07	end of BRIDGE project	1 0 Hz, 30' average
air quality	**Particle number size distribution**	Twin differential mobility particle sizer (3-950nm)	Hauke-type DMA (10.9 cm) +CPC (TSI3025), Hauke-type DMA (28 cm) +CPC (TSI3010)		ago-04	end of BRIDGE project	10'
air quality	**Principal outdoor pollutants (VOCs, contaminants, etc)**			With special request from the Finnish Meteorological Institute			
air quality	**SO_2 concentration**	UV-florescence technique	Horiba APSA 360	detection limit 0.2ppb	set-06	end of BRIDGE project	60 s, 30' average
air quality	**Soil gas profiles 3 depths**	sampling	Gas Cromatograph	From 2 streets	giu-03	end of BRIDGE project	1/14days
IAQ	**PM1, PM2.5, PM10**	Aerodynamic Particle Sizer (0.5-20μm)	TSI-3321	With special request from the Finnish Meteorological Institute		end of BRIDGE project	
meteo	**Air pressure**	online	Silicon aneroid barometer (Vaisala DPA500)		gen-03	end of BRIDGE project	4'
meteo	**Air temperature**	online	Platinum resistance thermometer (Pt-100)		mag-05	end of BRIDGE project	60 s
meteo	**air temperature (next to trees)**	online	radiation shielded Pt100, IEC 751 class B	From 2 streets	giu-03	end of BRIDGE project	10 '

meteo	**Precipitation**	online	Precipitation collectors & weighing rain gauge		nov-04	end of BRIDGE project	1'
meteo	**Relative Humidity**	Online	Vaisala DPA500		mag-05	end of BRIDGE project	4'
meteo	**Stormwater quality (Analyses of heavy metals, nutrients, organic pollutants etc)**	Auto sampler	ISCO3700	at three measurement stations/sub-drainage basins	fall 09	end of BRIDGE project	rain event
meteo	**Stormwater quantity**	online	Labkoteck ultrasound device	see above	fall 09	end of BRIDGE project	continuous
meteo	**u, v components**	Online	2-dimensional sonic anemometer (Vaisala WXT510)	From four levels	nov-04	end of BRIDGE project	10 Hz
micromet	**All three wind components (u,v and w)**	online	Metek USA-1		mag-05	end of BRIDGE project	10 Hz, 30' average
micromet	**Friction velocity, Sensible and latent heat fluxes and CO_2 flux**	Eddy covariance	Metek USA-1 + Open/Closed-path infrared gas analyzer (LI-7500/LI-7000)		dic-05	end of BRIDGE project	10 Hz, 30' average
micromet	**wind speed and direction**	Online	Metek USA-1		mag-05	end of BRIDGE project	10 Hz, 30' average
plant	**Diameter grothw (6 trees)**	online	Solartron (TM) displacement transducer	From 2 streets	giu-03	end of BRIDGE project	10 '
plant	**Diurnal stem and bark diameter variation (6 trees)**	online	Solartron (TM) displacement transducer	From 2 streets	giu-03	end of BRIDGE project	10 '
plant	**Sapflow (6 trees)**	online	Granier method	From 2 streets	giu-03	end of BRIDGE project	10 '
radiation	**PAR (next to trees)**	online	Delta-T Devices Ltd, QS2	From 2 streets	giu-03	end of BRIDGE project	10 '
radiation	**Up- and downward long- and short wave radiations + PAR**	online	Net radiometer and photodiode sensor (Zipp&Zonen, CNR1 + PAR Lite)		set-05	end of BRIDGE project	1'
soil	**Soil moisture profile3 depths**	online	Thetaprobes	From 2 streets	giu-03	end of BRIDGE project	10 '
soil	**Soil temperature profile3 depths**	online	Thermistors	From 2 streets	giu-03	end of BRIDGE project	10 '
Visual comfort	**Light distribution**				giu-03	end of BRIDGE project	10 '
Meteo	**Stormwater quality (Analyses of turbidity, conductivity and temperature of stormwater)**	online	Labkotec-sond: turbidity, conductivity	see above	fall 09	end of BRIDGE project	continuous
Weather station	**temp, rain, etc**	Automatic		rainwise	Jan -03	end of BRIDGE project	continuous

Case study: London							
participant		King's College London					
acronym		KCL					
category	**Variable**	**Method**	**Equipment**	**Notes**	**starting date**	**closing date**	**frequency**
air quality	**H_2O and CO_2 concentrations**	Gas Analysis (open/close path)	Open/Closed-path infrared gas analyzer (Licor Li-7500 & Li-840)	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
air quality	**NO_x concentration**		London Air Quality Network		depend ds on site	ongoing	15 '
air quality	**O_3 concentration**		London Air Quality Network		depend ds on site	ongoing	15 '
air quality	**Particle number size distribution**		London Air Quality Network		depend ds on site	ongoing	15 '
air quality	**Principal outdoor pollutants (VOCs, contaminants, etc)**					ongoing	
air quality	**SO_2 concentration**		London Air Quality Network		depend ds on site	ongoing	15 '
meteo	**Air pressure**	Capacitive silicon sensor	Vaisala WXT510	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
meteo	**Air temperature**	Capacitive ceramic sensor	Vaisala WXT510	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
meteo	**Precipitation**	tipping bucket	Vaisala WXT510 precipitation sensor & Campbell Scientific ARC100 Tipping Bucket			ongoing	
meteo	**Relative Humidity**	Capacitive thin film polymer	Vaisala WXT510			ongoing	
meteo	**Surface Temperature**	Infrared Thermometers	Raytek CI1A and CI2A		ago-08	ongoing	15 '
meteo	**u, v components**	2-dimensional sonic anemometer	Vaisala WXT510	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
micromet	**All three wind components (u,v and w)**	Sonic Anemometry	Campbell Scientific CSAT3	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
micromet	**Friction velocity, Sensible and latent heat fluxes and CO_2 flux**	Eddy covariance (EC)	Campbell Scientific CSAT3 + Open path infrared gas analyzer (Li-7500)	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
radiation	**Up- and downward long- and short wave radiations + PAR**	Net radiometer and silicon photocell Sensor	Kipp & Zonen CNR1 & Skye Instruments SKP215	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '
radiation	**UVA & UVB radiation**	Photodiode sensor	Skye Instruments SKU420 &	proper tower - Nov 1 2009	depend ds on site	ongoing	15 '

			SKU430				
		University of Southampton					
		SOTON					
air quality	**PM1, PM2.5, PM10**	EXCEL/GIS Information. Collation and analysis of existing met. Canopy cover and pollution data at two study sites (Firenze and London)	ArcMap, Matlab and UFORE based model.	Collation and analysis of existing data sets, and modelled / measured deposition velocities, supplemented by field sampling where necessary.	feb-09	ott-10	