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Data Management Plan

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1 INTRODUCTION

1.1 Purpose of the document

The URBANFLUXES (URBan ANthropogenic heat FLUX from Earth observation Satellites) Data Management Plan describes the management for all data sets that will be collected, processed or generated by the research project by using in-situ measurements, Earth Observation (EO) data analysis, as well as from Geographic Information Systems (GIS) analysis outputs. It is a document outlining how research data will be handled during a research project and even after the project is completed, describing what data will be collected, processed or generated and following what methodology and standards, whether and how this data will be shared and/or made open and how it will be curated and preserved.

1.2 Acronyms and Symbols

Acronyms

CoP	Community of Practice
EO	Earth Observation
GIS	Geographic Information Systems
LULC	LandUse/LandCover
UEB	Urban Energy Budget
UHI	Urban Heat Island
WP	Work Package
UF	URBANFLUXES
VHR	Very High Resolution
HR	High Resolution
MR	Medium Resolution
IPTC	International Press and Telecommunications Council

Symbols

Q_F	Anthropogenic heat flux
Q^*	Net all-wave radiation flux
Q_H	Turbulent sensible heat flux
Q_E	Turbulent latent heat flux
ΔQ_S	Net change in heat storage within the volume
ΔQ_A	Net advective flux

1.3 Document references

[R1] URBANFLUXES Grant Agreement, n. 637519, 05/11/2014

[R2] URBANFLUXES Consortium Agreement, 31/10/2014

[R3] Guidelines on Data Management in Horizon 2020

[R4] Colin Childs, ArcUser, 2009. The Top Nine Reasons to use a File Geodatabase, pg. 12-15.

[R5] Marzia Grasso and Max Craglia, 2010. D 2.2.3 European Open Source Metadata Editor (revised 2010-12-20), pg. 36.

2 PROJECT OVERVIEW

The anthropogenic heat flux (Q_F) is the heat flux resulting from vehicular emissions, space heating and cooling of buildings, industrial processing and the metabolic heat release by people. Both urban planning and Earth system science communities need spatially disaggregated Q_F data, at local (neighbourhood, or areas larger than the order of 100 m x 100 m) and city scales. Such information is practically impossible to derive by point *in-situ* fluxes measurements, while satellite remote sensing potentially is a valuable tool for estimating Urban Energy Budget (UEB) parameters exploiting Earth Observation (EO) data. While the estimation of Q_F spatial patterns by current EO systems is a scientific challenge, the major challenge lies on the innovative exploitation of the Copernicus Sentinels synergistic observations to estimate the spatiotemporal patterns of Q_F and all other UEB fluxes.

Several parameters describing the urban environment can be directly retrieved from EO data, such as the surface fractional cover, the surface albedo, emissivity and temperature. However, the main use of EO still remains the mapping of the urban land cover and morphology. All these parameters affect the UEB and relate to Q_F. Therefore, further investigation of the combination of satellite data with *in-situ* fluxes measurements and modelling, has the potential to reveal novel scientific insights on the role of Q_F within the UEB, although not specifically intended during the design of the current and expected in the near future satellite missions. With this goal, the synergistic use of remote sensing data acquired at different spatial resolutions and revisiting times seems very promising.

The main goal of URBANFLUXES is to investigate the potential of EO to retrieve Q_F, supported by simple meteorological measurements. The main research question addresses whether EO is able to provide reliable estimates of Q_F for the time of the satellite acquisition. URBANFLUXES will answer this question by investigating the potential of EO to retrieve Q_F spatial patterns, by developing a method capable of deriving Q_F from current and future EO systems. This method can be used operationally to derive spatiotemporal patterns of Q_F in the near future, when observations with adequate temporal resolution become available. URBANFLUXES therefore aims to develop an EO-based methodology easily transferable to any urban area and capable of providing Q_F benchmark data for different applications. URBANFLUXES is expected to increase the value of EO data for scientific analyses and future emerging applications (such as urban planning and local/regional level climate change mitigation/adaptation), by exploiting the improved data quality, coverage and revisit times of the Copernicus Sentinels data. To this end, the specific objectives of the project are:

- to improve the accuracy of the radiation balance spatial distribution calculation;
- to develop EO-based methods to estimate the flux of heat storage in the urban fabric;

- to improve EO-based methods to estimate turbulent sensible and latent heat fluxes and to evaluate them using flux measurement by *in-situ* Eddy Covariance instrumentation (or scintillometry) at selected case studies;
- to employ energy budget closure to estimate the anthropogenic heat flux spatial patterns at city scale and local scale (100 m x 100 m) at selected case studies;
- to specify and analyse the uncertainties associated with the derived products;
- to evaluate the products by comparisons with anthropogenic heat flux estimations by independent methods and models;
- to improve the understanding of the impact of the anthropogenic heat on energy budget, Urban Heat Island (UHI) and urban climate; and to communicate this understanding to the urban planning community, which will in turn lead to a better understanding of what new knowledge is needed on the ground;
- to investigate the potential of exploitation of the Sentinels 2 and 3 synergistic observations to combine local scale and city scale observations, capable of retrieving Q_F and of the remaining UEB fluxes at the local scale, with the frequency of the Sentinel 3 series acquisitions.
- to develop a highly automated method for estimation of UEB components from Copernicus data, enabling its integration into applications and operational services;
- to standardise the resulting products, and by organizing an effective dissemination mechanism, to enhance their use by urban planners and decision makers in cities, as well as by EO scientists, Earth system modellers and urban climatologists;
- to support sustainable urban planning strategies relevant to climate change mitigation and adaptation in cities, by taking into account the contribution of Q_F.

URBANFLUXES is expected to generate a novel analysis method for estimation of UEB components from Copernicus data, enabling its integration into applications and operational services; for example to: develop rules of thumb for density and green space ratio, distinguish between insulated and non-insulated buildings/neighbourhoods and evaluate the implementation of climate change mitigation technologies such as solar-screening, green-belting and carbon-cooling. Despite its local importance, Q_F is omitted from climate models simulations. Observations of global temperature evolution indicate a pronounced warming over the last 150 years, with an increase in the occurrence of heat waves. The added value and benefit expected to emerge from URBANFLUXES is therefore related to quality of life, because it is expected to improve our understanding of the contribution of Q_F to heat wave intensity and thus to allow insight into strategies for mitigation. Q_F estimates are needed for all cities to be able to document the magnitude of the fluxes effects on urban climate so that the impact of Q_F can be included in climate modelling. URBANFLUXES is therefore expected to advance the current knowledge of the impacts of Q_F on UHI and hence on urban climate, and consequently on energy consumption in cities. This will lead to the development of tools and strategies to mitigate these effects, improving thermal comfort (social benefit) and energy

efficiency (economic benefit). The long term operation of the Sentinels series guarantees the future supply of satellite observations, providing the means for the development and realization of the URBANFLUXES methodology.

The energy balance residual approach will be used in URBANFLUXES. Although a rather straightforward method when the rest UEB components are known, its primary drawback is the accumulation of estimation errors of each energy budget flux in Q_F and the error of having neglected any unmeasured terms. Errors in the estimated flux terms include those stemming from normal observation inaccuracies plus the real spatial variability of the surface energy budget. The Q_F considered here captures only the effects of energy released within the system, which is not necessarily equivalent to energy consumption, as for example for the case of buildings, due to the heat transfer resistance between buildings and atmosphere and the thermal inertia of buildings. Q_F is estimated by regressing the sum of the turbulent heat fluxes versus the available energy, defined for every pixel. Given that UEB closure is achieved, the regression will result in Q_F, estimating also the respective uncertainty.

Three different urban areas are selected in URBANFLUXES as case studies: a highly urbanized mega city (London), where high values of Q_F are expected in all seasons; a typical central European medium size city, that requires a substantial amount of energy for heating (Basel metropolitan area); and a smaller, low latitude Mediterranean city with dynamic urbanization process that requires a substantial amount of energy for cooling (Heraklion). In both Basel and Heraklion lower Q_F values are expected; however the two latter cases are considered as representative test-beds to investigate possible limitations of the URBANFLUXES methodology. In all cities local scale and city scale Q_F estimations will be performed. Satellite observations will be analysed for typical days for all seasons taking also into account the synoptic meteorological conditions in the selection of these days. The effort will focus on both work days and holidays for each season. Especially for Heraklion, emphasis will be given on mapping of Q_F spatial patterns in summer, when the energy demand is high due to the air conditioning usage. To develop a method that will be welcomed by potential users, it is important to involve them in the project from the beginning. The project uses a Community of Practice (CoP) approach, which means that in the case studies, local stakeholders and scientists of the URBANFLUXES project will meet on a regular basis in order to learn from each other. The CoP will make clear what aspects are important for the future users of the URBANFLUXES products. The scientists, in turn, explain what the possibilities and limitations of the methods and models are. The interactions are informal and open in order to lead to an increased understanding of the system under study for both the future users and the scientists. It also provides network contacts for collecting spatial and non-spatial datasets for each case study. This approach will also be used to create an “umbrella” CoP across the participating cities, as well as with the broader scientific community, to exchange ideas and experience of the URBANFLUXES products on a European level.

3 DATA REPOSITORY - TYPES OF DATA PRODUCED - MANAGEMENT

URBANFLUXES Consortium has chosen to participate on a voluntary basis in the H2020 Pilot on Open Research Data. An on-line archive, as a repository for the scientific publications, expected during and after the project, has been developed in the URBANFLUXES web-server. This web-server is operated by FORTH and also hosts the Data Repository, the project web-site and the ftp-server for internal data and information exchange. The URBANFLUXES web-server is a PowerEdge R730xd server with Intel Xeon CPU, 32 GB of Ram and 48 TB HDD's on a RAID 10 backup and monitoring system. From the 48 TB of available storage space, 24 TB will be available for use in the project and 24TB for backup actions in the project. Also, 2 HDD of 300 GB for OS and SW, will serve the website of the project and through it, all deliverables and public available publications and data.

Machine-readable digital copies of the published versions or final peer-reviewed manuscripts accepted for publication will be deposited in this repository for scientific publications (Publications Repository). This will be done at the latest upon publication, even where open access publishing is chosen in order to ensure long-term preservation of the article. At the same time the research data needed to validate the results presented in the deposited scientific publications will be deposited into the Data Repository. The URBANFLUXES web-server will ensure open access to the deposited publications and underlying data. Depending on each specific publication, either the self-archiving (green open access), or the open access publishing (gold open access) option will be selected. In the former case the Consortium will ensure open access to the publication within a maximum of six months. In the latter case, open access will be ensured upon publication and the author processing charges incurred by beneficiaries are eligible for reimbursement during the duration of the project. After the end of the project, these costs will be covered by partners' Organizations. The URBANFLUXES web-server will also ensure open access - via the repository - to the bibliographic metadata that identify each deposited publication. The bibliographic metadata will be in a standard format and will include: the terms "European Union (EU)" and "Horizon 2020"; the name of the action; the acronym and the grant number; the publication date; the length of embargo period if applicable, and a persistent identifier, such as Digital Object Identifier (DOI).

The URBANFLUXES Data Repository will be the common place for the storage and management of the data. Access will have the participants of the URBANFLUXES and the potential users of the products and outputs (see Section 6). It will store raw data, auxiliary data, products and their associated metadata, documents and multimedia that will come out in the next years from the URBANFLUXES Consortium. The URBAFLUXES datasets and products can be distinguished into two main categories:

1. Spatial Data:

a. Vector Data (figures 1 & 2).
b. Raster Data (Figures 3 & 4).
c. Collections of data in tables (netCDF, HDF, CSV - tabular format with values separated by commas, Matlab files).

2. Non-Spatial Data:
   a. Reports
   b. Dissemination material
   c. Scientific publications
   d. Deliverables
   e. Multimedia files:
      i. Photographic material
      ii. Videos for the promotion of the project / Documentaries

Figure 1. Building blocks, building footprints and road network as vector data (Heraklion).

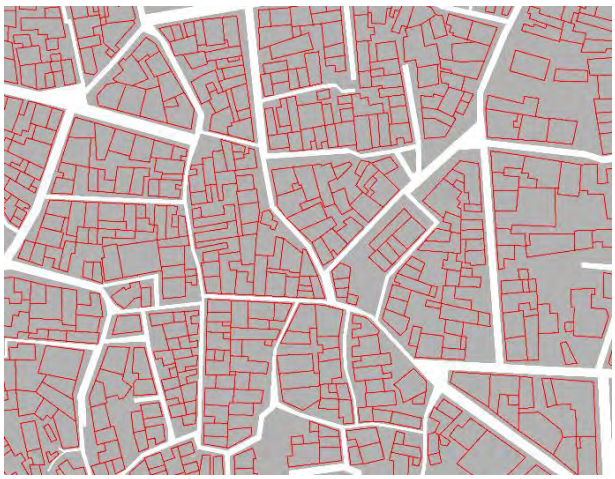

Figure 2. Details from the building footprints and the building blocks (Heraklion).

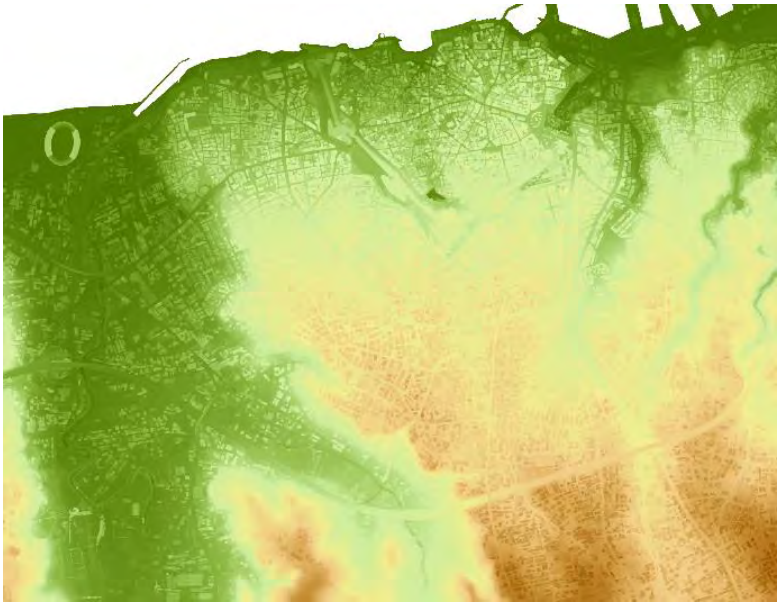

Figure 3. Digital Surface Model (DSM) as raster file at 0.8 m x 0.8 m posting.

Figure 4. WorldView II acquisition over the historic centre of Heraklion.

URBANFLUXES has arranged all available spatial data in a folder management system in the URBANFLUXES web-server. The same structure will be used for the produced data during and after the end of the project. The data is accessible through the URBANFLUXES web-site (Figure 5). The data can also be accessible through ftp clients (Filezilla, SmartFTP, etc.), as shown in

Figure 7. All URBANFLUXES products related to publications are open and free after registration to the URBANFLUXES web-site.

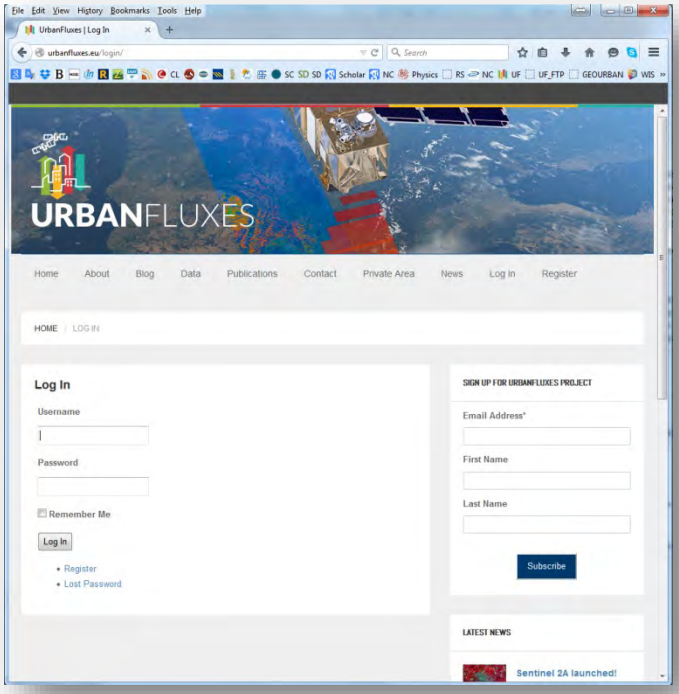

Figure 5. Access to URBANLUXES Data Repository.

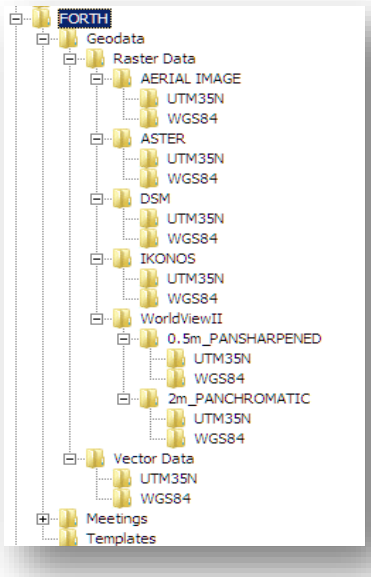

Figure 6. The folder based Data Management Scheme, as is in the URBANFLUXES web-server

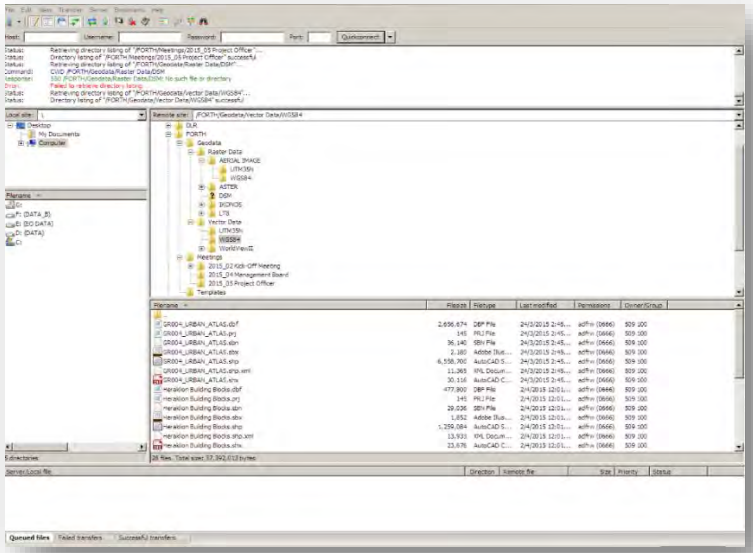

Figure 7. The file structure of the URBANLUXES Data Repository accessed by FILEZILLA ftp client software.

Vector data will be produced by analyzing very high resolution imagery (VHR), either satellite or aerial. The analysis of this data will lead to the following products:

- Buildings and associated information (categories, height, building material)
- Building blocks and types
- Road network and associated information (road type)
- Tree locations, canopy and height
- Local Climate Zones (LCZ)

Moreover, the following vector data has become available by the Local Authorities at the URBANFLUXES Case Studies:

- Building blocks
- Building footprints
- Road Network
- Green spaces

This data will be updated, as the area changes through time, based on the analysis of recent VHR imageries by applying state-of-the-art methods and tools. Vector data will be in the format of shapefile, a standard and open format for vector data during the last decades. It is compatible with a variety of software, either desktop or web-based.

Raster data will include satellite or aerial derived parameters, such as:

- Landuse/Landcover (LULC)
- Land Cover type fractions
- Digital Surface Models
- Urban surface morphometric parameters (Sky-view Factor, Height to Width ratio, etc.)
- Vegetation phenology (Leaf area index - LAI, Enhanced vegetation index- EVI and Normalized difference vegetation index – NDVI).
- Water body (Lakes, Rivers, etc.)
- Surface reflectance
- Surface temperature
- Surface emissivity
- Surface albedo
- Soil moisture content
- Aerosol optical thickness
- Cloud cover

The satellite images that to be analyzed include:

- Sentinels 1 (SAR), 2 (HR) and 3 (MR) - Archived & new acquisitions
- ASTER custom night flights (HR) – New custom acquisitions
- LANDSAT mission (TM, ETM+, ETM+ SLC off and OLI/TIRS) (HR) - Archived & new acquisitions
- SPOT (HR) - Archived & new acquisitions
- PLEIADES (VHR) - Archived & new acquisitions
- IKONOS (VHR) – Archived images
- QUICKBIRD (VHR) - Archived images
- WORLDVIEW II (VHR) – Archived & new acquisitions
- Aerial Color Images (VHR) and Lidar - Archived images

The information will be extracted periodically; in specific time steps, e.g. every year, month and season, depending on the needs of the project's WP's. This will be decided upon project Consortium. Raster data will be stored in the format of GeoTIFF or JPEG2000. GeoTIFF is a well-known, widely used uncompressed raster format. Its only disadvantage is its large file size comparing to other formats. JPEG2000 is a new format, highly compressed with no loss of information and with a size almost half of the GeoTIFF. Both formats are readable from a variety of software's desktop or web based solutions (Web-gis portal). Raw satellite images will be stored separately, with their associated metadata files as these are provided by the image

provides. If needed, additional metadata, in order to simple the information from the native metadata files, will be created in simple text format with the name of the file.

Furthermore, data from in-situ measurements by the wireless networks of meteorological stations (wind speed and direction, air temperature and humidity, surface temperature, incoming solar radiation), as well as products by Eddy Covariance systems and scintillometers (turbulent heat fluxes), will be used in URBANFLUXES. Detailed time series of this data in dedicated formats (netCDF, CSV - tabular format with values separated by commas, etc.) are already kept by the Partners that have the responsibility of in-situ measurements in URBANFLUXES Case studies: Basel, London and Heraklion (UNIBAS, UoR and FORTH, respectively). Links to the web-sites that each of the above Partners makes freely available the original time series exist in the URBANFLUXES web-site.

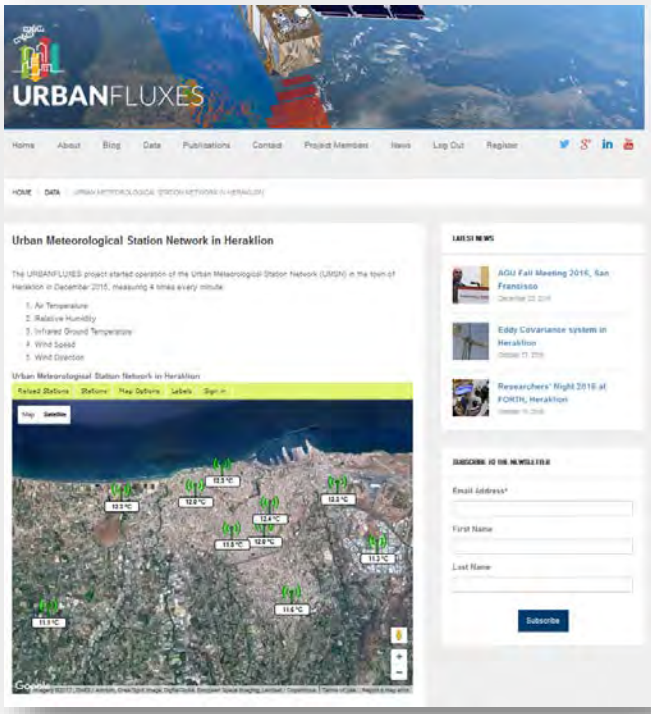

Figure 8. Access to weather station data for Heraklion by using the web-GIS application of the URBANFLUXES web-site.

Moreover, UNIBAS and FORTH have the option to make the wireless sensors network measurements available via the Sensorscope Climaps cloud storage and thus a web-GIS application is developed in order to provide real-time overview of the meteorological station network recordings in these two cities (Figures 8, 9). The use of cloud storage of this type

ensures the accessibility of the data during field work (calibrations, normal checks, field campaigns) and will act as a backup storage. Temporally aggregated time series of this data, meteograms, as well as all the datasets needed to support the publications included in the URBANFLUXES Publications Repository, are made freely available in URBANFLUXES Data Repository and through the web-GIS applications.

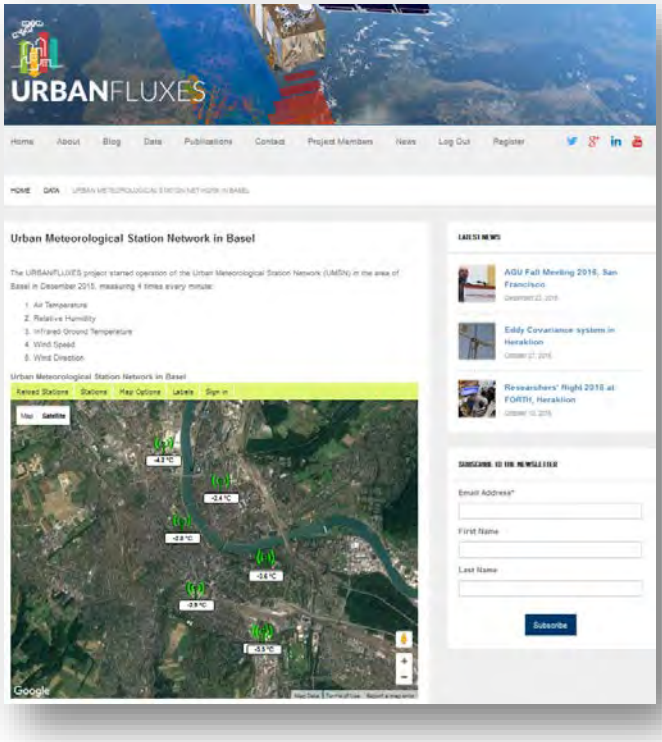

Figure 9. Access to weather station data for Basel by using the web-GIS application of the URBANFLUXES web-site.

An alternative to the folder based management scheme can be also implemented in URBANFLUXES Data Repository: the ESRI Geodatabase [R4], personal or file, as a common storage for the above mentioned file types. This alternative has the following advantages:

- Incorporation of topology rules in vector data.
- Improved versatility and usability.
- Storage of raster files.
- Optimized performance due to the data structure.

- Easy of data exchange (one geodatabase per study area, one with the deliverables of the project) through the web.
- Possibility to have “folders” aka “feature datasets” in the database and the smaller size of the data due to compression, as shapefiles and raster cannot be compressed.

4 COORDINATE SYSTEM

The UTM WGS84 projection is used as a project standard. When URBANFLUXES products are made available to Local Authorities they can be re-projected to the local coordinate system, if needed. All data in the URBANFLUXES Data Repository will be converted to UTM, each one for the three case study locations (table 1).

Table 1. Coordinate systems of the study areas.

	Coordinate systems	
	UTM and EPSG code	Local System
London	WGS84 Zone 31N - (EPSG:32631)	
Basel	WGS84 Zone 32N - (EPSG:32632)	CH1903+ LV95 (EPSG 2056)
Heraklion	WGS84 Zone 35N - (EPSG:32635)	GGRS87 / Greek Grid (EPSG 2100)

5 METADATA

A metadata standard, which is currently used by most of the project partners, will be adopted in URBANFLUXES for the spatial products (i.e. maps of heat fluxes). A template will be developed according to the INSPIRE standards for the spatial data while for the meteorological observations, a simple Excel form with the necessary information will be created. URBANFLUXES partners can use the online editor and viewer for the INSPIRE metadata standard (Figure 10) which can be found at: http://inspire-geoportal.ec.europa.eu.

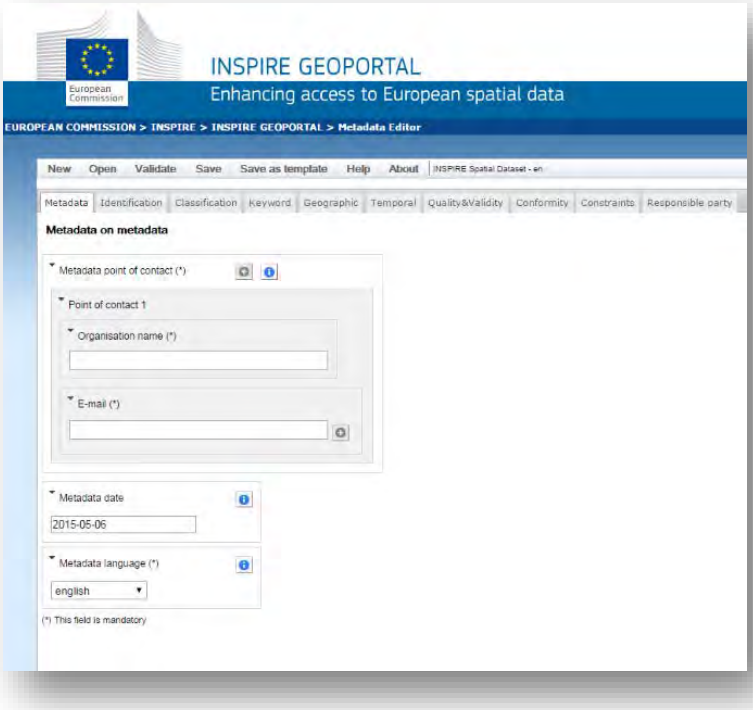

Figure 10. The interface for the INSPIRE metadata editor.

This editor contains a limited number of obligatory metadata and can be extended with much more information. It allows designing a metadata template that fits the needs of URBANFLUXES, requiring only so much information as needed, to reduce the workload, as for each dataset (vector and raster), metadata have to be created. This can be exported in the form of standard XML. There is a possibility to use also an offline INSPIRE metadata editor for a more efficient metadata creation, like the GIMED, the ArcCatalog metadata editor It should be ensured that all relevant information for the different WPs and users (internal and external) is stored in the metadata. An example for the Land Cover map for London is provided below (Figure 11) and the XML with the metadata from the INSPIRE metadata editor (APPENDIX).

The information that the metadata can have for the spatial data are:

1. Metadata on metadata:
    a. Point of contact
    b. Email
    c. Metadata date
    d. Metadata language

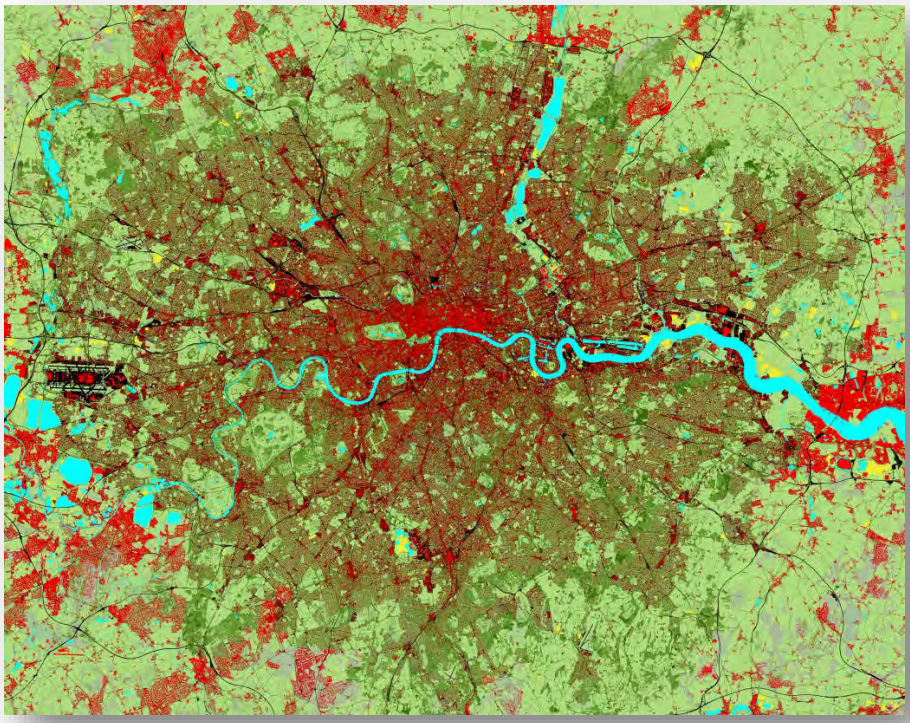

Figure 11. Land Cover map for London. The metadata of this image (raster file) can be found in the appendix of the report.

2. Identification:
    a. Resource title
    b. Identifier
    c. Resource abstract
    d. Resource locator
3. Classification:
    a. Topic category
4. Keyword
    a. Keyword from INSPIRE Data themes
    b. Keywords from repositories
    c. Free keywords
    d. Originating controlled vocabulary
        i. Title
        ii. Reference date

iii. Data type

5. Geographic
    a. Bounding box
    b. Countries
6. Temporal reference
    a. Temporal extend
        i. Starting date
        ii. Ending date
    b. Date of creation
    c. Date of publication
    d. Date of last revision
7. Quality and Validity
    a. Lineage
    b. Spatial resolution
        i. Equivalent scale
        ii. Resolution distance
        iii. Unit of measure
8. Conformity
    a. Specifications
    b. Date
    c. Data type
    d. Degree
9. Constraints
    a. Conditions applying to access and use
    b. Limitations on public access
10. Responsible party
    a. Organization name
    b. Email
    c. Responsible party role

These are the INSPIRE guidelines that can be applied to the spatial datasets of the URBANFLUXES project [R5].

Table 2 contains the fields that are required for the correct classification and description of the URBANFLUXES products, and the respective fields of the INSPIRE directive.

Table 2. List of mandatory for URBANFLUXES metadata fields,

	Name of field	Name of the respective INSPIRE field	Visible in the web-site list
1	Owner/Publisher	Metadata→ Organization name + email Responsible Party → Organization name + email + role	
2	Title	Identification → Resource Title	YES
3	File name	Identification → Identifier → Code	
4	Short Description	Identification → Resource abstract + Resource locator	
5	Topic category	Classification → Topic category	
6	INSPIRE keyword	Keyword → Keyword from INSPIRE Data themes	
7	Keywords	Keyword → Free keyword → Keyword value	
8	Geographic location	Geographic → Geographic bounding box	
9	Temporal Extent	Temporal → Temporal Extent	YES
10	Reference Dates	Temporal → Date of Creation, Publication, last revision	
11	Process history	Quality&Validity → Lineage	
12	Spatial Resolution	Quality&Validity → Resolution distance + Unit of measure	YES
13	Access and use	Constraints → Conditions applying to access and use + Limitations on public access	
14	File size	*(automatic)*	YES

5.1 Metadata File Creation Walkthrough

In this section directions for the metadata creation are given along with a draft example (asterisks* indicate that the field is already fixed in template forms, see Section 5.1.15):

5.1.1 Owner/Publisher

In **Metadata** tab, fill in the fields:

- **Organization name** (i.e. *FORTH*)
- **E-mail** (i.e. *mitraka@iacm.forth.gr*)

Do the same for **Responsible party** tab:

- **Organization name** (i.e. *FORTH*)
- **E-mail** (i.e. *mitraka@iacm.forth.gr*)
- **Responsible party role*** (i.e. *Author*)

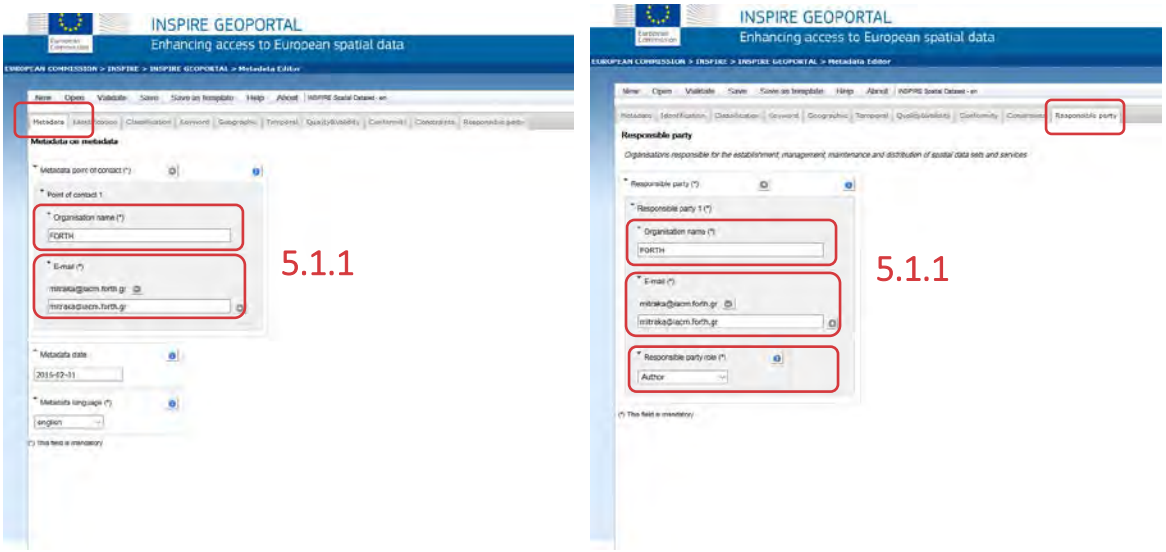

Figure 12. Metadata tab and Responsible party tab.

5.1.2 Title

In **Identification** tab, fill in the fields:

- **Resource title** (i.e. *Sky-view factor (Basel)*)

This is the most important field, because it describes the content of the dataset, which is visible by the users on the online portal. After the title **always put the city name in parenthesis** (already set in the templates).

5.1.3 File name

In **Identification** tab, fill in the fields:

- **Identifier Code** (i.e. *Basel_SVF*)

This code must be unique for each resource and is mandatory by INSPIRE Metadata Editor

5.1.4 Short Description

In **Identification** tab, fill in the fields:

- **Resource abstract** (i.e. *The sky-view factor is the fraction of sky visible from the ground level.*)
- **Resource locator*** (i.e. http://urbanfluxes.eu)

This is a short description on what the data refers to, technical specification and/or some reference for the dataset.

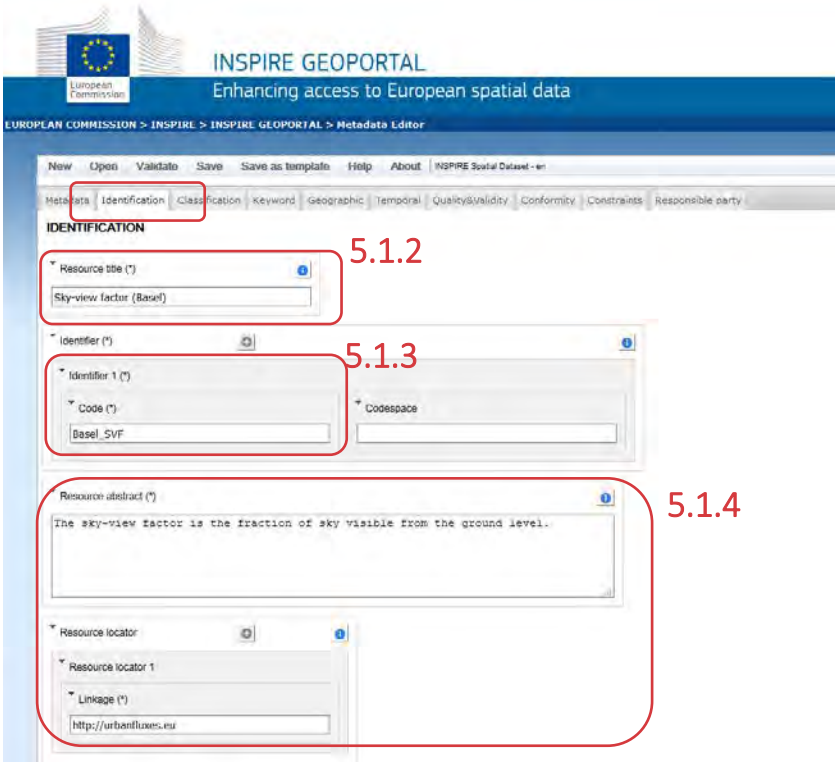

Figure 13. Identification tab.

5.1.5 Topic category*

In **Classification** tab, fill in the fields:

- **Topic category*** (i.e. *Geoscientific Information*)

It is a mandatory field of the INSPIRE directive to select one of the high-level classification scheme that is proposed by the Metadata Editor. It has been decided to use one category for all URBANFLUXES products (i.e. *Geoscientific Information*).

Figure 14. Classification tab.

5.1.6 INSPIRE Keyword

In **Keyword** tab, fill in the fields:

- **Keyword from INSPIRE Data themes** (i.e. *Meteorological geographical features*)

It is mandatory to select one keyword from the INSPIRE Data themes. Some relevant keywords are: Bio-geographical regions, Buildings, Elevation, Land cover, Land use, Meteorological geographical features.

5.1.7 Keywords

In **Keyword** tab, fill in the fields:

- **Free keywords** (i.e. *Basel SVF DSM*)

The **city name must always be one of the keywords** (already set in the templates) in order to be searchable in the online database. Other keywords can be added after the city name depending on the type of the dataset. **Each keyword must be written independently** (not altogether or comma-separated) in the *keyword value* field and press *Apply* after each keyword. The list of keywords is visible in the box at top of the page. You can remove any wrong keywords pressing the "minus" sign next to each keyword.

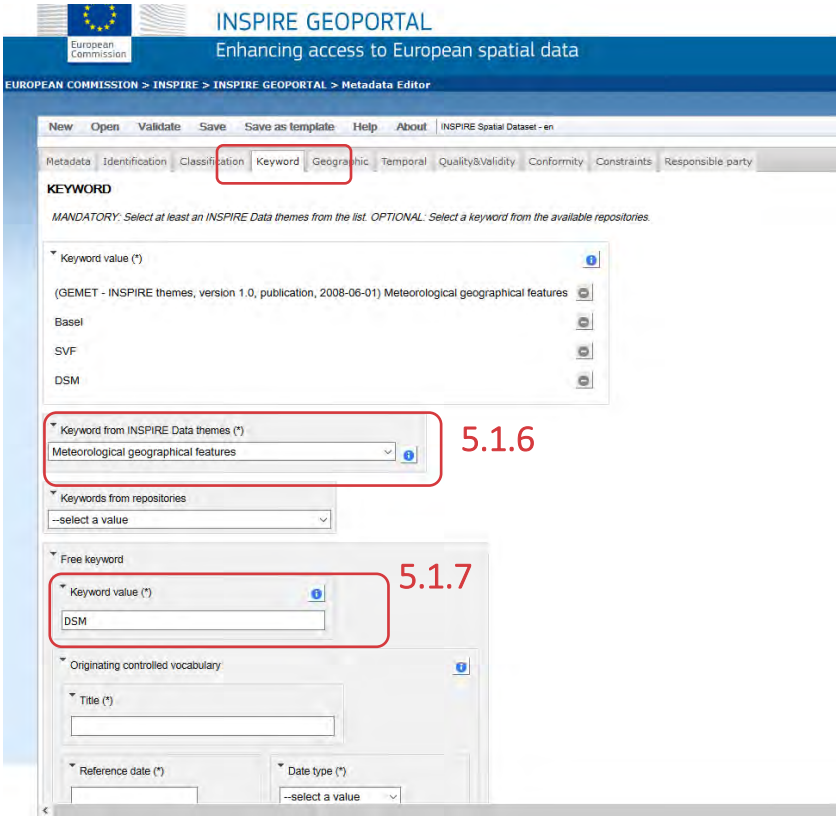

Figure 15. Keyword tab.

5.1.8 Geographic location*

In **Geographic** tab, fill in the fields:

- **Geographic bounding box*** (i.e. *47.64 N, 7.72 E, 47.46 S, 7.44 W*)

The geographic bounding box of the spatial dataset is required in decimal degrees with precision of at least two decimals. For example, the full grid of Basel is **47.64** N, **7.72** E, **47.46** S, **7.44** W. When the degrees are completed in the respective fields, plus sign must be pressed in order to create the bounding box.

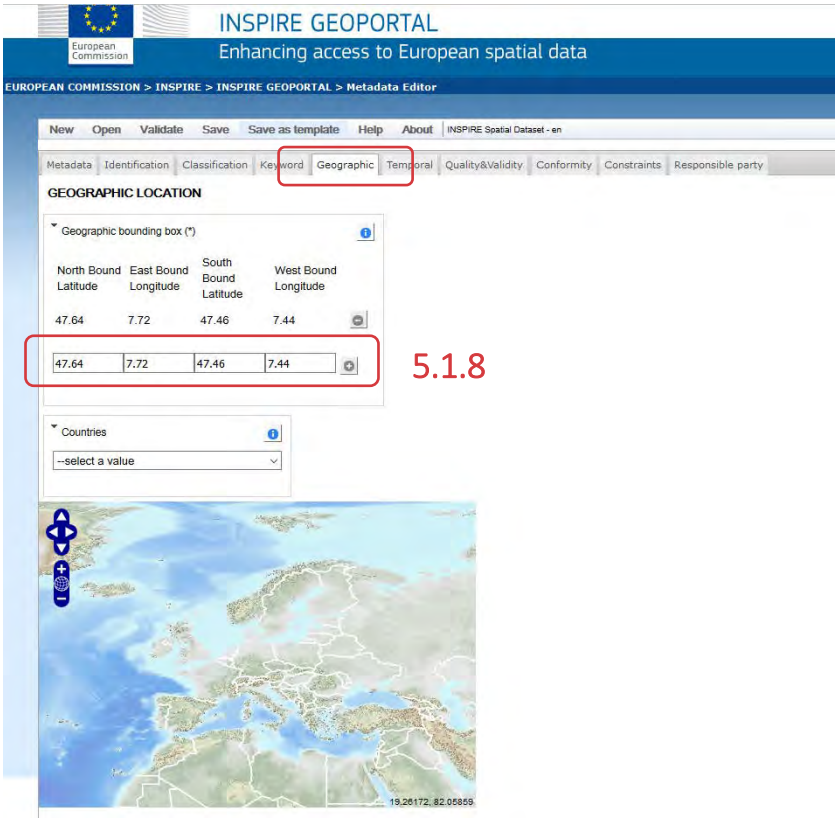

Figure 16. Geographic Location tab.

5.1.9 Temporal Extent

In **Temporal** tab, fill in the fields:

- **Temporal Extent** (i.e. *2015-01-01, 2015-12-31*)

The temporal extent defines the time period covered by the content of the resource. Individual dates, as well as time intervals, or the mix of the two can be inserted. When referring to an individual date, the date must be inserted in *Starting date* and *Now* is applied in *Ending date*. When referring to a time interval *Starting* and *Ending dates* are completed.

5.1.10 Reference Dates

In **Temporal** tab, fill in the fields:

- **Date of creation** (i.e. *2015-12-04*)
- **Date of publication** (i.e. *2016-02-02*)
- **Date of last version** (i.e. *2016-02-02*)

The completion of the reference dates (creation, publication, last revision) is optional, yet their completion may be important for us in the future to keep track of the published material. *Date of publication* can be the same with the date creating the metadata file (i.e. *Metadata date* in *Metadata* tab).

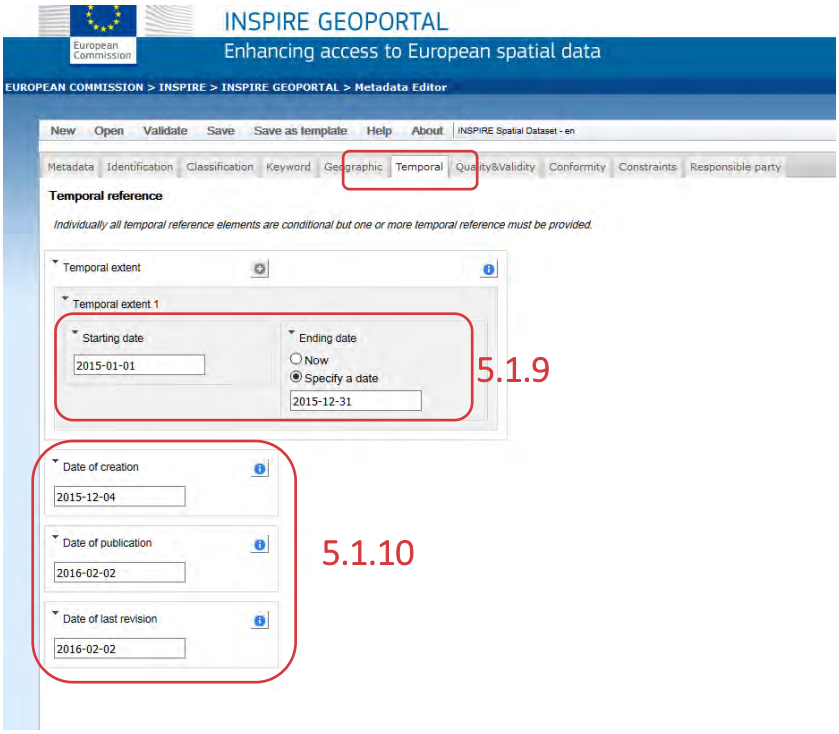

Figure 17. Temporal tab.

5.1.11 Process history

In **Quality&Validity** tab, fill in the fields:

- **Lineage** (i.e. *The sky view factor was created using two high resolution (1 m) Digital Surface Models, one for the buildings and another one for city trees. It was created using the approach of Lindberg, F., & Grimmond, C. S. B. (2010). Continuous sky view factor maps from high resolution urban digital elevation models. Climate Research, 42(3), 177–183. http://doi.org/10.3354/cr00882 This project has received funding from the*

European Union's Horizon 2020 research and innovation programme URBANFLUXES under grant agreement No 637519)

All the information regarding the

- data sources,
- the methodology,
- the version of the dataset (in case we upload some revision in the future for the same dataset),
- the references,
- the quality and the validation (if available)
- reference to the funding* (the sentence "*This project has received funding from the European Union's Horizon 2020 research and innovation programme URBANFLUXES under grant agreement No 637519"* must be set in the end of every Lineage field)

should be summarized in the *Lineage* field.

5.1.12 Spatial Resolution

In **Quality&Validity** tab, fill in the fields:

- **Resolution distance** (i.e. *1*)
- **Unit of measure** (i.e. *meters*)

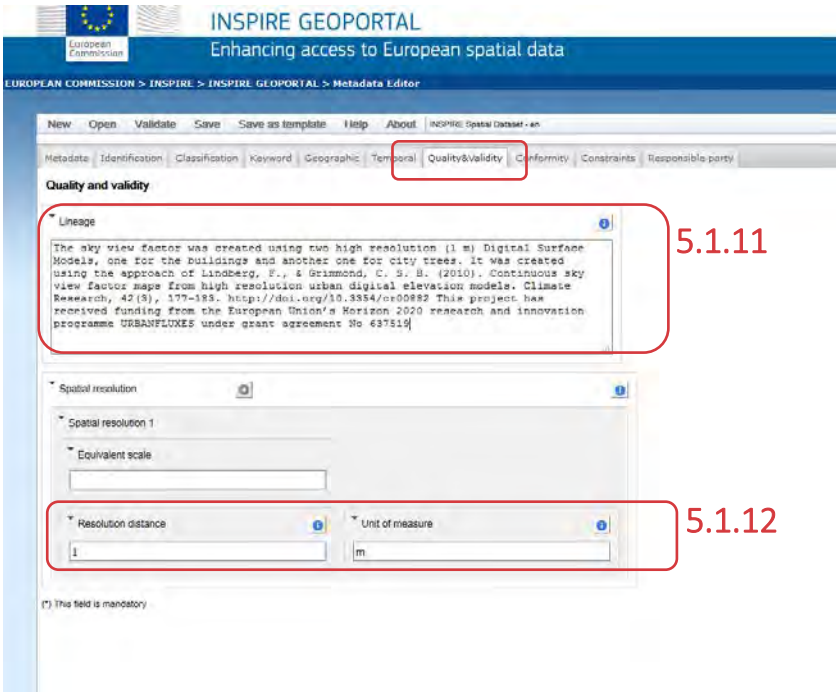

Figure 18. Quality&Validity tab.

5.1.13 Access and use*

In **Constraints** tab, fill in the fields:

- **Conditions applying to access and use*** (always: *Free access and use to registered URBANFLUXES users*)
- **Limitations on public access*** (i.e. *Intellectual Property Rights*)

Another mandatory field of the INSPIRE directive is the definition of the conditions and the limitations of the access and use of the data. As defined by [R1], [R2], [R3], the users will have the possibility to access, mine, exploit, reproduce and disseminate (free of charge) the data, including associated metadata. The users gain free access to the data after the online registration to URBANFLUXES website. Therefore, the sentence "***Free access and use to registered URBANFLUXES users***" is completed in the *Conditions applying to access and use* field. Since URBANFLUXES data are protected by ***Intellectual Property Rights*** [R1], [R2], [R3], the respective suggestion (e) in the *Limitations on public access* field is chosen pressing ENTER in the empty field.

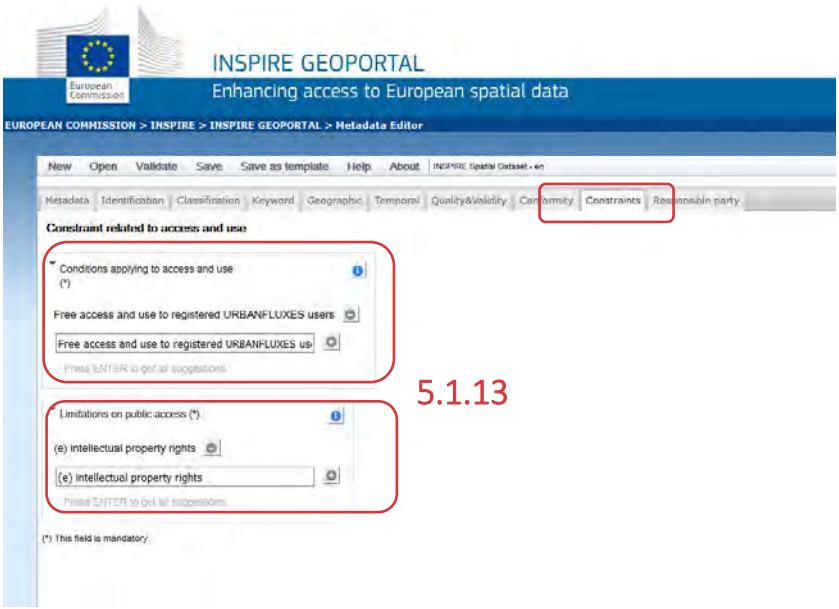

Figure 19. Constraints tab.

5.1.14 File size

Not applicable within INSPIRE, it will show automatically for URBANFLUXES data.

5.1.15 Use of Templates

To avoid filling the same fields over and over again, one can use a template according to the case study. Template xmls for Basel, London and Heraklion have been created. By using the template, the fields one needs to fill only the fields below:

5.1.1 Owner/Publisher (Responsible party role is already set)

5.1.2 Title (City name in parenthesis is already set)

5.1.3 File name

5.1.4 Short description (Resource locator is already set)

5.1.6 INSPIRE keyword

5.1.7 Keywords (City name is already set as keyword in the templates, you just need to put the rest of the keywords)

5.1.9 Temporal extent

5.1.10 Reference dates

5.1.11 Process history (The last sentence is the funding reference and is already set)

5.1.12 Spatial resolution

5.2 Weather Station Metadata

For weather stations and in-situ measurements, different information will be used in the metadata so that the instruments that measure the variables are described. As well as the entries from the Spatial metadata (excluding spatial-specific entries 5 and 7), these are:

Sensor information

- Sensor type
- Manufacturer
- Sensor model
- Serial number
- Firmware version
- Measured variable identifier(s)
- Measurement unit of each variable
- Accuracy of each variable
- Raw sampling rate
- Transmission rate

Installation information

- Connection type / Transmission technology
- Position (X, Y information in WGS84)
- Height of the instrument above ground (m)
- Estimated height of surrounding buildings (m)
- Vertical and horizontal orientation of instrument (degrees)
- Instrument mounting description
- Data format
- Photograph(s) of the station and immediate surroundings after installation

The above information will be stored in a designed form in Excel, named with the station's name and the instrument serial number. A consistent set of variable names and measurement units for the weather stations should be agreed upon by the URBANFLUXES Partners before the metadata are populated. It is noted that equipment may need replacing at a particular station and it will be clear when this happens in the framework of the project.

To access to the data description with simple tools, contextual information about the data (one per product) will be added in a text based document. This will contain less information than the XML suggested by the INSPIRE Directive or the form containing the weather station metadata. However, this information will be enough to describe the data. Information on the creation date, data source, scale, creator, life span in cases of temporal update will be included in the text file. Information on the source of dataset, time window, expiration date scale of the dataset, owner should be included in both the XML and the TXT files. The final products will be made available through the URBANFLUXES Data Repository hosted in the project's web server. These products will be accompanied by their metadata, based on the INSPIRE Directive.

The non-spatial data will have their own metadata. For multimedia files (photography and video - documentary), keywords based on IPTC protocol for metadata will be used. The list of keywords will be defined by the Consortium. For the documents, keywords from a predefined list can be used either within the text or at the attributes of each file (doc, docx, pdf) in order to become searchable through the website.

6 POLICY FOR RE-USE, ACCESS AND SHARING

6.1 Data Repository

The URBANFLUXES Data Repository will be split into two segments:

- The Public Data Repository, where URBANFLUXES products become freely available to all after the provision of basic information [R2].
- The Private Data Repository, where raw data, unpublished data, as well as all internal documents will be available to the URBANFLUXES Consortium [R2].

6.2 Public Data Repository

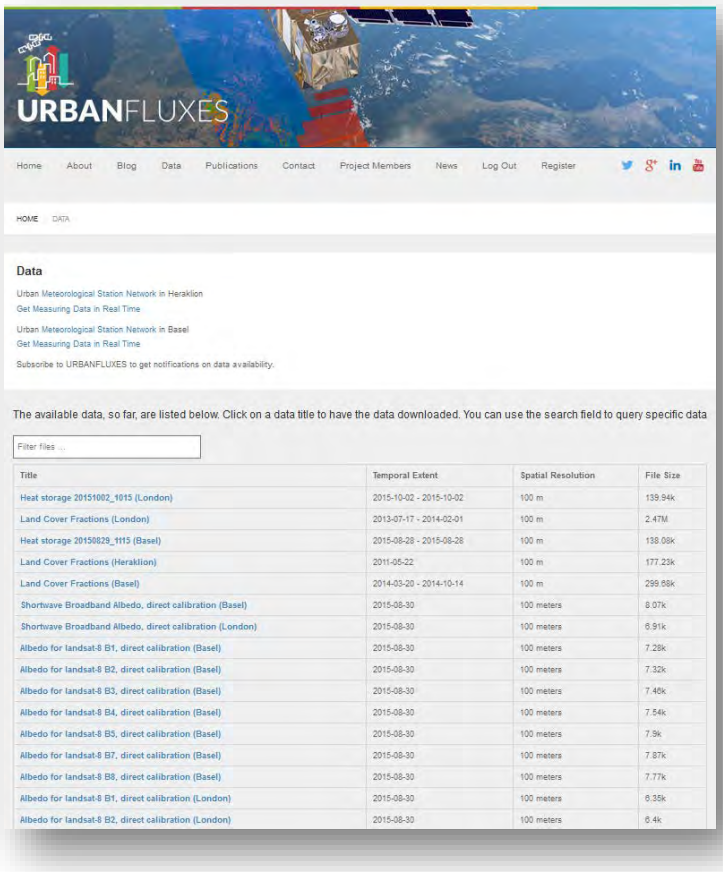

Figure 20. The Data Repository section at the URBANLUXES website.

After the publication of the scientific publication presenting the analyses methods to be developed in URBANFLUXES, the respective data and products will become available with free

access through the URBANFLUXES in the Public Data Repository (Figure 20). Any potential user of these datasets will have free access, following simple instructions given in the respective web-page. The user will fill in a dedicated form with minimum information (name, email, etc.), similar to which several projects use (JRC, UN, EEA, etc.) and then will grand access to these datasets. The users will have the possibility to access, mine, exploit, reproduce and disseminate (free of charge) the data, including associated metadata, needed to validate the results presented in scientific publications, as well as and other data, including associated metadata. By following this procedure, the URBANFLUXES Consortium will monitor the diffusion of these products, as well as the reuse in other projects, publications, supporting in this way new scientific collaborations. The registered users will be being automatically informed by the system when new public datasets become available. During the course of the project, a questionnaire including questions related to the use of the acquired dataset, will be sent to the registered users to identify the final use of the data in cases of differences from the submission phase (data download). Such an action will provide insights on the usefulness of the produced data and will support decisions on future products.

6.3 Private Data Repository

The Private Data Repository, hosted in URBANFLUSEX web-server, will include the raw data (satellite images, vector data from public sources), the unpublished results and data that have been classified as confidential according to the Consortium agreement [R2]. The member of the URBAFLUXES (Table 3) will have access by login with their credentials. Data that is used and produced during the project will be available. Raw data and products or intermediate datasets will be online for sharing with the partners for further exploitation. Raw data will be available to the members of the URBANFLUXES Consortium according to the rules in the Consortium Agreement [R2].

Table 3. The current list of users with access to the Private Data Repository

Name	Organization
Nektarios Chrysoulakis	FORTH
Zina Mitraka	FORTH
Dimitris Poursanidis	FORTH
Stavros Stagakis	FORTH
Thomas Esch	DLR
Wieke Heldens	DLR
Jean-Philippe Gastellu-Etchegorry	CESBIO
Ahmad Al Bitar	CESBIO
Sue Grimmond	UoR
Simone Kotthaus	UoR
Andrew Gabey	UoR
William Morrison	UoR

Eberhard Parlow	UNIBAS
Christian Feigenwinter	UNIBAS
Roland Vogt	UNIBAS
Andreas Wicki	UNIBAS
Fredrik Lindberg	UoG
Frans Olofson	UoG
Fabio Del Frate	GeoK
Daniele Latini	GeoK
Judith Klostermann	ALTERRA
Channah Betgen	ALTERRA

7 PLANS FOR ARCHIVING AND PRESERVATION

The data products will be updated frequently and according to the needs of the project as these will evolve and be specified by the scientists of the project. The production date will be included in both the file name (LT8LULC20150430.tif) and the associated metadata (LT8LULC20150430.xml, LT8LULC20150430.txt). Version of the updated data products will be retained in the data storage system (folder or geodatabase). A revisit history document will describe the revisions made, the person that made them and will accompany them in the long term preservation. Frequent backups (monthly) of the data included in the data repository of the URBANFLUXES web-server will be automatically performed by FORTH. Also, weekend incremental backup will be active for the huge data of the project. RAID 10 system will be used in the URBANFLUXES web-server and 24TB of storage space will be available for this crucial step. Manual backups will be retained if necessary by using external HDD's and safe storage in safe. If the data that will be used and produced by the URBANFLUXES project increase in volume and the concreted storage volume become insufficient for the security and the backup of the data, addition storage space will be obtained as the additional data volume and the server maintenance cost will not be barriers for the long term preservation and distribution of the data. In the long-term the high quality final data products generated by URBANFLUXES project will become available for the use by the research and policy communities in perpetuity.

8 APPENDIX

INSPIRE Metadata XML created with the INSPIRE Metadata Editor for the "LandCoverMap_London.tif" file.

The template is available from http://inspire-geoportal.ec.europa.eu/editor/

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http://schemas.opengis.net/iso/19139/20060504/gmd/gmd.xsd"
xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns:gco="http://www.isotc211.org/2005/gco"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:gml="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink">
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<gco:CharacterString>Basel_LCM_SPOT5</gco:CharacterString>
</gmd:fileIdentifier>
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<gco:CharacterString>Landcover map of Basel obtained by SPOT5 products with spatial resolution 2.5m. Following classes are considered:water, low vegetation, decidous, bare soil, evergreen, impervious surfaces, buildings. The classification algortithm makes use of Neural Network techniques (F. Del Frate , F. Pacifici, G. Schiavon, C. Solimini, “Use of neural networks for automatic classification from high resolution imagery,” IEEE Transactions on Geoscience and Remote Sensing, vol. 45, n. 4, pp. 800-809, April 2007) and Spectral Angle Mapper analyses(Kruse, F. A., A. B. Lefkoff, J. B. Boardman, K. B. Heidebrecht, A. T. Shapiro, P. J. Barloon, and A. F. H. Goetz, 1993, “The Spectral Image Processing System (SIPS) - Interactive Visualization and Analysis of Imaging spectrometer Data.” Remote Sensing of the Environment, v. 44, p. 145 - 163.). External validation has been carried out which provided an overall accuracy exceeding 80%.This project has received funding from the European Union’s Horizon 2020 research and innovation programme URBANFLUXES under grant agreement No 637519</gco:CharacterString>
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