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URBANFLUXES

URBan ANthrpogenic heat FLUX from Earth observation Satellites

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1 INTRODUCTION

1.1 Purpose of the document

This document explains the participatory methodology for stakeholder involvement of the URBANFLUXES (URBan ANthropogenic heat FLUX from Earth observation Satellites) Project. The report aims to provide the URBANFLUXES partners with practical guidelines on the launching and sustaining of Communities of Practices in the cities of London, Basel and Heraklion. It contains information on different methods for stakeholder involvement for each of the case studies.

After a general introduction of the URBANFLUXES project, the overall method of a Community of Practice (CoP) will be described. An inventory will be made for possible tools to be used in support of the CoP meetings, for example, open space workshops, brown-paper sessions, scientific posters and tools for monitoring the learning process. Additionally, a method for interviews with researchers and end users is described. Finally the document comprises a draft planning for the CoP meetings.

1.2 Definitions and acronyms

CARePOL	Climate change adaptation in Norway, Sweden, and Finland – do research, policy and practice meet?
Climate-ADAPT	European Climate Adaptation Platform
CLIM-RUN	Climate Local Information in the Mediterranean region Responding to User Needs
CLIPC	Climate Information Portal for Copernicus
CoP	Community of Practice
DSS	Decision Support System
ε	error
EO	Earth Observation
EU	European Union
EUPORIAS	EUropean Provision Of Regional Impacts Assessments on Seasonal and decadal timescales
ISENES	InfraStructure project of the European Network for Earth System Modeling
JPI Climate	Joint Program Initiative Climate
Q*	net all-wave radiation flux
ΔQ_A	net advected flux ($\Delta Q_A = Q_{in} - Q_{out}$)
Q_E	turbulent latent heat flux
Q_F	anthropogenic heat flux

Q_H	turbulent sensible heat flux
ΔQ_S	net change in heat storage within the volume (including the flux into the ground)
S	all the other sources and sinks
ToPDAd	Tool-supported Policy Development for regional Adaptation project
UEB	Urban Energy Budget
UHI	Urban Heat Island
URBANFLUXES	URBan ANthropogenic heat FLUX from Earth observation Satellites
WP	Work Package

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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 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 the Urban Energy Budget (UEB) parameters exploiting Earth Observation (EO) data. The estimation of Q_F spatial patterns by current EO systems is therefore a challenge; however, the major challenge for the EO community is the innovative exploitation of the Copernicus Sentinels synergistic observations to estimate the spatiotemporal patterns of Q_F and all other UEB fluxes.

Traditionally, *in-situ* heat flux measurements have been used to quantify components of the UEB. Whilst such measurements typically provide the best estimates of the fluxes, they are representative of only small areas. Given that urban surfaces are usually complex mixtures of different land covers and surface materials, the relative magnitude of the energy balance components typically will vary widely across a city, and will almost certainly depart significantly from those in the restricted area measured by the *in-situ* instrumentation. In contrast, EO provides the advantage of large-area, or near complete, spatial coverage and a relatively high spatial resolution. However, the methods used to derive energy fluxes via satellite remote sensing of urban areas are still under development, as is the optimum spatial scale at which to make such observations. Moreover, the relative accuracies of the various approaches have yet to be properly identified and documented. Several parameters describing the urban environment can be directly retrieved using EO data, such as surface fractional cover of different land cover materials which can be used to infer land-use types, albedo, emissivity and variables such as surface 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 (URBan ANthropogenic heat FLUX from Earth observation Satellites) 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. Methods to estimate UEB related products from EO will be developed and by combining these products the Q_F spatial patterns will be derived. 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, including UEB models to assess the implication of Q_F on the urban climate; building energy models to characterize buildings-to-atmosphere/soil/water heat exchange pathways; Decision Support Systems (DSS) for urban sustainable planning and mapping of pollutant emissions related to energy consumption in urban areas. 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 proposed project are:

- to use *in-situ* reflectance measurements of urban materials to calibrate the EO data to be used;
- to exploit EO 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 (1 km x 1 km) 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 the anthropogenic heat.

URBANFLUXES will enhance the scientific and operational exploitation of the existing and emergent European space infrastructure, by stimulating the emergence of novel ideas on how UEB components can be observed from space, focusing on the estimation of the spatiotemporal patterns of anthropogenic heat. 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 (extended periods of anomalously high summertime temperatures). Satellite monitoring of extreme heat events and estimates of associated public health impact and the quality of life in cities are recent developments, however they have confirmed the critical influence of extended anomalously warm nocturnal temperatures on excess mortality. 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). URBANFLUXES impact will be maximized by successful dissemination of results to both scientific (Earth system modellers, EO scientists, urban climatologists) and urban planning communities. The dependence of the URBANFLUXES method on EO data is one of its key advantages, given the potential for transferability to any city. An easy and low-cost implementation to any city is expected. The research therefore will have the potential to support sustainable urban planning strategies, by taking into account the spatiotemporal distribution of Q_F in cities. 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.

$$Q^* + Q_F = Q_H + Q_E + \Delta Q_S + \Delta Q_A + S \quad (W\ m^{-2}) \qquad (1)$$

The energy balance residual approach (Offerle et al. 2005, Pigeon et al. 2007) 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, in Equation (1), 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. In the framework of URBANFLUXES this spatial variability will be derived from satellite observations. Therefore, given small or unbiased ΔQ_A (net advected flux ($\Delta Q_A = Q_{in} - Q_{out}$)and S (all the other sources and sinks) in Equation (1) and determining Q^* (net all-wave radiation flux), Q_H (turbulent sensible heat flux), Q_E (turbulent latent heat flux) and ΔQ_S (net change in heat storage within the volume) directly from EO data, with the support of standard meteorological observations, the expected value of the residual term would be a reliable estimate of Q_F, since, from a measurement perspective, it is impossible to remove anthropogenic contributions from the other terms in Equation (1). 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 ($Q_H + Q_E$) versus ($Q^* - \Delta Q_S$), defined for every pixel. Given that UEB closure is achieved, the regression will result in Q_F, estimating also the respective uncertainty. The following assumptions are made:

1. All energy consumed in buildings is released into the environment after use.
2. Based on current research knowledge, it seems accurate to consider the term S in the UEB, under which all yet unknown processes are summarized. These processes are comparatively small, but one possible contributor to this term may be rainwater, which absorbs heat from the surface (Offerle et al. 2005). Further investigation is needed, however in URBANFLUXES this term will be neglected, because in case of rain, the spatial resolution of the respective satellite derived information is coarse for local or even city scale applications, whereas in other cases S is too small to be detected by the current and forthcoming satellite technology. To this end, it is also assumed that the heat-to-wastewater flux is entirely removed by the underground wastewater collection system and the latent heat emission from evaporative cooling towers is low in URBANFLUXES study areas.
3. Advection is a term that has been neglected in past studies as its influence was considered small and often the assumption of horizontal homogeneity was adopted. Advection occurs at all three scales: at the microscale, horizontal advection occurs e.g. for sensible heat between shadowed and sunlit patches and for latent heat between

wet and dry patches; at the local scale, advective fluxes may occur due to the close proximity of urban parks, water bodies, and between built-up areas of different density; meso-scale advection occurs between the city and the surrounding rural environment (urban breeze), or, for coastal cities, due to the presence of sea breezes. The surrounding topography may also induce anabatic/katabatic effects. If ΔQ_A is comparatively high, then the horizontal advection must be taken into account in UEB estimation. On the contrary, the moisture advection is converted to equivalent latent heat flux. Pigeon et al. (2003) made estimates of the advection term for the city of Marseille, using a network of temperature and humidity sensors and conclude that the advective fluxes of latent and sensible heat are of similar size but are opposite in sign, thereby essentially offsetting each other. Based on this work, it can be assumed that horizontal heat and moisture advection, while present, is not a major contributor to error in estimates of Q_F as an energy budget residual. Concerning the local scale study, it is assumed that ΔQ_A is incorporated in the error (ε) of Q_F estimation from the energy balance closure.

Three different urban areas are selected in URBANFLUXES as case studies (Figure 6): 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. In order 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 will use a Community of Practice (CoP) approach (González et al. 2011), 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, will explain what the possibilities and limitations of the methods and models are. The interactions will be 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 COMMUNITIES OF PRACTICE (COP)

3.1 Introduction

In this chapter the concept of Communities of Practice is introduced. The main characteristics are described and Communities of Practice are compared with other organizational structures. Finally the possibilities and limitations of a Community of Practice for the URBANFLUXES project are discussed.

3.2 What is a Community of Practice?

Communities of Practice are groups of people who share a concern or a passion for something they do and who learn how to do it better as they interact regularly (Wenger, 2002). Communities of Practice develop around things that matter to people. The members of a community deepen their knowledge and expertise in a particular area by interacting on an ongoing basis. Examples of Communities of Practice are a band of artists seeking new forms of expression or a group of engineers working on similar problems.

A Community of Practice can be characterized by three core dimensions: the domain, the community and the practice. If a group of people develops these three elements in parallel it constitutes a Community of Practice.

The domain

A Community of Practice is not merely a network of people. It has an identity defined by a shared domain of interest. Membership implies a commitment to the domain, and a shared competence that distinguishes its members from other people. A domain can be any kind of expertise like ‘tomato growing’, ‘urban planning’, ‘empowerment’ or ‘surviving on the street’.

The community

In pursuing their interest in a specific domain, the members of a CoP build relationships that enable them to learn from each other. They engage in joint activities and discussions, help each other, and share information. Members of a Community of Practice interact on a regular basis. The Impressionists, for instance, used to meet in cafes and studios to discuss the style of painting they were inventing together. These interactions were essential to create a Community of Practice, even though they often painted alone.

The practice

Members of a Community of Practice develop a shared practice. Together they create a repertoire of resources: methods, tools, experiences, stories, and ways of addressing recurring problems. This takes time and sustained interaction. Nurses who meet regularly in a

hospital cafeteria may not even realize that their lunch discussions are one of their main sources of knowledge about how to care for patients. In the course of all these conversations, they develop a set of stories and cases that become a shared repertoire for their practice.

The concept of community of practice has found a rich and growing number of practical applications in business, organizational design, government, education, development projects, professional associations, and civic life.

Memphis Group

The Memphis Group was a design and architecture group founded in Milan by Ettore Sottsass in 1981. Industrial design in the 1970's always started from what was technically and commercially feasible. Memphis was a reaction against minimalistic, brown or black, humorless design. They challenged the idea that products had to follow conventional shapes, textures and patterns. The Memphis Group offered bright, colorful, shocking pieces. They designed furniture, fabrics, ceramics, glass and metal objects from 1981 to 1987. The group was dismantled in 1988. It has influenced graphic design, fabrics and furnishing until today.

Carlton Bookcase, Ettore Sottsass, 1981.
New York: The Metropolitan Museum of Art

3.3 Communities of Practice versus other structures

Communities of Practice are known under various names, such as learning networks or thematic groups. While they all have the three elements of a domain, a community, and a practice, they come in a variety of forms. Some are quite small; some are very large. Often they have a core group and many peripheral members. Some CoP's are local and some cover the globe. Some meet mainly face-to-face, others mostly online. Some are within an organization and some include members from various organizations, projects or networks.

Some are formally recognized, supported with a budget; while others are informal and hardly visible. And some are deliberately started inspired by the literature on CoP's, while others function like a CoP naturally without using the concept itself.

While there is a lot of variety, there also are some important boundaries outside of which we cannot speak of a CoP anymore. Communities of Practice are different from other organizational groups such as formal working groups, project teams or informal networks. They also differ from communities of interest, in which people tend to gather around a particular issue, but the participants are not practice-oriented. See Table 1 for a comparison of CoP's with other groups and networks.

Table 1: Differences between a Community of Practice and other organizational structures (van Winkelen, 2009)

	Purpose	Membership	Duration
Community of Practice	Developing members' professional capabilities by building and exchanging knowledge and experience	More or less closed membership Interaction based on willingness to contribute with knowledge and experience Membership creates a feeling of belonging	As long as there is commitment from the members
Formal working group	Delivering a product or service	Membership assigned by management Members are committed to fixed agreements and tasks	Until there is no longer a demand for the product or service
Project team	Accomplishing a task within a specific period of time	Closed membership Members are committed to fixed agreements and tasks	Until the end of the project
Informal networks	Collecting and exchanging information	Relatively open membership Aims for creating relationships Interaction based on information exchange	As long as people feel the need to connect

3.4 Principles for developing Communities of Practice

Communities of Practice are (at least partly) voluntary and they develop organically. What makes them successful over time is their ability to generate enough excitement, relevance and value to attract and engage its members. The main question is how to design and facilitate for aliveness?

Based on experience, a framework of seven principles is suggested to generate "aliveness" and energy within Communities of Practice (Wenger, 2002). These principles acknowledge that, while Communities of Practice need to be spontaneous and self-directed, guidelines can be helpful in creating the conditions for them to flourish. The seven principles are summarized in Table 2.

Table 2: Seven principles for generating aliveness and energy within a Community of Practice (Wenger, 2002)

Principle 1	Design for evolution	Retain an important part of the community, but also allow new people to become involved and new interests to be explored. Accept that there will be different activity levels and different kinds of support needed at different times.
Principle 2	Open a dialogue between members of the community and people outside the community	Encourage a discussion between those within and those outside the community about what it could achieve.
Principle 3	Invite different levels of participation	Some people will be active in the community and some people will appear passive. Accept that contributions and learning take place in different ways.
Principle 4	Organize both formal and informal events	Formal organized events are needed to help people feel part of a community. Relationships are formed during informal community events. Both are important.
Principle 5	Focus on value	The true value of a community may emerge as it matures and develops. Community members should be encouraged to be explicit about the value being delivered. This

		may help to raise awareness and to sustain motivation over time.
Principle 6	Combine familiarity and excitement	Familiar community activities help people to feel comfortable in participating. Introducing new ideas to challenge thinking also stimulates interest and keeps people engaged.
Principle 7	Create a rhythm for the community	Regular events create points around which activity can converge. They encourage people to keep coming back.

3.5 Communities of Practice within URBANFLUXES

A Communities of Practise functions where there is a shared domain, a community and a shared practice (Wenger, 2002). For the URBANFLUXES project the shared domain would be urban heat and the urban energy balance. Researchers as well as stakeholders from municipalities may want to learn more about this, but they are likely interested in different aspects.

As for the community, the project will invest in a start-up of the CoP. For the long term, only the participants inside or near the cities will be able to continue meeting each other. A network at the European scale is too costly for most municipalities.

Concerning the development of daily practices, the project will have to create a space in which all participants have something to learn and something to gain from it. All participants should have some influence on the agenda (if there is an agenda).

If the CoP's function, there will be important benefits for the researchers of the project; however, if the CoP's also benefit the other groups remains to be seen. A project structure with clearly defined deliverables may inhibit a free exchange process (Klostermann et al, 2014). Therefore, it is important to 'manage the expectations'; and to look for methods of interaction that create a level playing field and sufficient openness for learning in all directions.

4 METHODS AND TOOLS IN SUPPORT OF THE COP MEETINGS

4.1 Introduction

Engaging user groups in scientific projects is a difficult enterprise (Groot et al, 2014). Some of the problems that were identified:

- The information of scientists is not understandable for the user groups;
- The user groups lack the time to learn something new;
- Professional expertise on communication and participation is often lacking;
- There is insufficient investment in good communication between scientists and user groups.

General advice to improve the process:

- Involve skilled communicators;
- Organize regular contact;
- Manage expectations;
- Build trust;
- Try to understand the concerns, questions and goals of the user groups;
- Identify user requirements in an iterative process because the user groups will learn about their own needs during the project.

Below we provide short descriptions of methods and tools that can help to improve the interaction with user groups. Not every one of them has to be used in the project; we provide a flexible list of options in this chapter.

4.2 Structural methods for involving users in the project

4.2.1 User consultation panel

A user consultation panel represents (possible) users of a product, whether this is a new website or a household appliance. A panel is used to gather opinions on the goal of a product, on aspects during the creation of the product and evaluates the product when it is finished, or even remains involved for questions when the product is in use. The panel can be consulted by different means, such as a survey, an interview or participating in a workshop.

The Climate Information Portal for Copernicus (CLIPC) makes use of a user consultation panel. The panel was created by sending out an online survey to potential users from similar EU projects, the networks of people involved in CLIPC and via websites such as Linkedin (Groot et al, 2014).

If it is known beforehand what type of user is necessary to consult (for example users from a specific sector), possible users or businesses can be more directly addressed.

To keep a user consultation panel actively engaged, the panel needs to be consulted on their specific needs and the product has to contribute to those needs.

4.2.2 Users committee / stakeholder board

A user committee or stakeholders board is a smaller motivated group from the user consultation panel that is involved in different stages of the project providing feedback (Groot et al, 2014). Several projects have already made use of a committee or board. For the European Climate Adaptation Platform (Climate-ADAPT[1]) a small user group, related to the formal Adaptation Steering Committee, was kept engaged through online discussion sessions. Every time a new version of the platform was delivered it was discussed with the committee. The EU project EUPORIAS[2] has established a stakeholder board covering all sectors involved in the project based on the partners' network. Regular communication is ensured with different communication tools (email, social media, newsletters, etc.) (Groot et al, 2014).

4.2.3 User consultation workshops

A user consultation workshop is very often used in EU projects; CLIPC, CLIM-RUN, Climate ADAPT, JPI Climate, ToPDAd and ISENES all made use of workshops to consult their users (Groot et al, 2014). On holding a workshop, JPI Climate mentions that preferably workshops or meetings should not be limited to only one, as the continued and informed engagement of users is critical to both the development and delivery of climate services (the product in this project). Workshops can for example have a plenary character, work with different sessions or combine both methods. If subgroups are used during a workshop, users can be divided, for example according to user type (CLIPC) or sector (CLIM-RUN). In the case of EU projects it can be difficult to involve actual end users to participate in workshops (ToPDAd project).

4.2.4 Qualitative interviews

Qualitative interviewing is a method of stakeholder interaction that is often used in European scientific projects (CLIM-RUN, JPI Climate, CARePOL, EUPORIAS and CLIPC (Groot et al., 2014)). By engaging users in (semi-structured) interviews, a lot of information can be retrieved on their needs and information gaps. With an interview you have the benefit of being able to deepen the answers to questions, which you do not have in a survey. EUPORIAS interviewed 80 users for their research and CLIPC 25. To get users to agree on participating in an interview it is good to invite them personally (either by email or face-to-face) or to ask them to participate after they filled in a survey.

[1] http://climate-adapt.eea.europa.eu/
[2] http://www.euporias.eu/

4.2.5 Questionnaire/online survey

A questionnaire or online survey can serve as a quick way to get answers to some simple questions. If formulated correctly, these answers can already provide a project with a great deal of information. The CLIPC project had 90 respondents from different types of users from around Europe. EUPORIAS had almost 500 respondents. Trying to get possible users to participate in an online survey requires a huge effort of distributing the survey through different channels if a large response rate is needed. It is therefore important to understand that a survey can be very time consuming.

4.2.6 Joint sessions during progress meetings

The URBANFLUXES project team has regular progress meetings which can be combined with a session where the stakeholders are invited to participate.

4.2.7 Joining stakeholder meetings

When the stakeholder groups are known, it can be considered to search for existing meetings that involve those stakeholders and ask if someone from the URBANFLUXES project team can join their meeting. In such a meeting stakeholders can be approached and the benefits of participating in the research can be conveyed. This creates trust and allows a stakeholder to have the initial contact within his/her own comfort zone.

4.2.8 Monitoring by stakeholders

In the URBANFLUXES project, observational meteorological data is used as input to calculate the urban fluxes. For example, the Dutch meteorological office used data from weather amateurs to gather information on city climate. Providing stakeholders with small meteorological stations to make their own temperature measurements gives them a sense of real involvement and contributes to the data collection.

4.3 Methods that can be used within workshops

4.3.1 Open space workshop

Open space workshop is a method that is part of the Open Space Technology created by Harrison Owen (Owen, 2008). It is based on the assumption that the most useful conversations occur during the coffee breaks. During an open space workshop, people are seated in a circle. According to Owen, a circle is the fundamental geometry of open human communication. There is no set agenda at the start of the workshop. A bulletin board is created by the attendees with points for discussion and an open marketplace determines which issues will be discussed in what way. An open space workshop has the ability to unite groups of enormous diversity on all aspects (education, ethnicity etc.). There are five conditions to using open space technology, there should be: a real (business) issue; a great deal of complexity involved; lots of diversity in terms of people and points of view; real

passion and probably also conflict; and genuine urgency of the issue (Owen, 2008). The method is particularly powerful when nobody in the room knows the answer.

4.3.2 Brown-paper session

A brown-paper session is a participatory method to jointly visualise something, such as a process or model (van den Berg and Pietersma, 2014). A brown paper poster is placed on a wall. Participants are requested to write down questions and answers on post-its and place them on the paper. The post-its are then clustered. It is a method often used to identify bottlenecks in (work) processes, but its foremost goal is to actively engage participants to join a discussion.

4.3.3 Field visit

Visiting the field makes an abstract discussion more clear by looking at the subject in real-life. It creates a basis for common understanding among stakeholders (Krishnaswamy, 2004). For example, studying architecture by looking at pictures of buildings does not give you the feeling of grandeur that you might experience when seeing a building in real-life. In the URBANFLUXES project stakeholders will get a far better idea of the problems associated with heat in a city when walking through the city on a warm day and then travelling outside the city to observe the difference in temperature. If stakeholders also can see possible solutions, it can help them to get inspired.

4.3.4 Strategy development

Developing a strategy helps when a change has to be made. This can be either because a problem occurs which needs to be resolved or because there is a need for progress instead of standing still. Four questions are important when developing a strategy (McKeown, 2012). They can be somewhat changed to be more applicable to the URBANFLUXES project:

- What are you doing at the moment? /What is the current situation?
- How does that compare to your competitors? / How does this compare with future changes?
- What do you want to achieve? / What solutions or options are available?
- How can you create something people want? / How can we create interest in the solutions or options we propose?

By involving stakeholders in this process and getting their opinions, it is more likely that the strategy can actually be implemented. The stakeholders are already enthusiastic and they will motivate others.

4.3.5 Scenario development

A scenario is defined as "a postulated sequence or development of events[3]". By developing different scenarios for the future, different options on how to deal with each scenario can be discussed. For example, in the case of urban heat, one scenario can be developed where people adapt to urban heat by purchasing an air conditioner. Then you can discuss what the consequences of that scenario will be, more air conditioning probably leads to more energy fluxes from buildings, enlarging the problem. Another example of a scenario could be if more green spaces were developed in a city, then again discussions can start on what consequences that would have on the energy fluxes within a city.

4.3.6 Mind mapping

The method of mind mapping starts with a central theme around which a tree diagram is drawn explaining aspects associated with the central theme. These aspects are then again further divided into explanatory branches. It involves a structured approach, but every person makes different mind maps because of differing associations with the central theme. Mind mapping can be done in groups bringing all associations to a theme together in one diagram, or they can be made individually followed by discussion in small groups.

4.3.7 Climate Atelier approach

In the Netherlands, a lot of interaction is organized with stakeholders. One approach is the climate atelier approach involving the Natural Alliance method. The climate ateliers involve local stakeholders and aim at making their knowledge visible on maps. By creating small groups of people and giving them drawing material and solutions for problems, they can discuss options and make a shared spatial plan for an area.

4.3.8 Touch table

A touch table is a large tablet (80x100cm) that can be placed on a table or wall allowing people to look at spatial data. A map can have several layers of underlying data that can be made visible at request. Since heat fluxes largely depend on spatial data, such as building density, amount of green spaces and waterbodies, plotting this data on the table allows for a quick insight where problems might occur. The touch table has a zoom function which allows users to see the data on different spatial scales. The table can also be used as a drawing tool. Because it is an interesting piece of relatively new technology, users are very much drawn to the table and want to interact with it.

4.3.9 Training sessions

Once stakeholders have an idea of what the problem is and what solutions can be offered it might be beneficial to train the stakeholders into creating solutions. To reduce heat in cities a

[3] http://www.oxforddictionaries.com/definition/english/scenario

solution might be to create more green spaces. A training session might then focus on how procedures to apply for a permit to create green space are fixed or a training session on how to stimulate/facilitate neighbourhood initiatives to create more green spaces.

4.4 Methods enhancing further communication with users

4.4.1 Scoping document

A scoping document can be made to inform potential users on the goals of the project. It can also include a project charter, a name, the project justification, as well as project requirements, milestones, and deliverables. A reduced and understandable form of this document can be attached to an invitation to the users to participate in for example a survey or a workshop. It can also work as a document to manage expectations.

4.4.2 Glossary

A glossary is a definition of terms which is often helpful to explain terms which are unfamiliar to users. It is also very important to have a glossary in order to minimize misunderstandings about terminology (Groot et al., 2014). In the scientific community there might be an understanding on certain terms, but it is highly unlikely this is shared by users outside the scientific community. According to the CLIM-RUN project, especially societal end users have a strong need for a glossary of terms. EUPORIAS has a separate glossary of terms section on their website. Additionally, terms are highlighted in the various texts that direct readers to the glossary. CLIPC will add a glossary to their website. A FAQ (frequently asked questions) section can also help users understand the project.

4.4.3 Scientific posters

Scientific posters can visualise information in an understandable way and can work as a factsheet providing information on the different subjects within the URBANFLUXES project. For example, one scientific poster can explain the different fluxes within a city that are of natural origin, another poster can explain the anthropogenic fluxes within a city and a third poster can explain why this project is important for the users.

4.4.4 Social media interaction / Blog

Interacting with your users through social media or a blog is relatively new and not yet applied on a large scale (in the scientific community). Social media are platforms such as Linkedin, Facebook and Twitter. A blog can be posted on a project website and/or shared via social media channels. It is an easily accessible method of interaction for a user. Especially social media is something most users already use in their daily life, so it does not require a lot of extra effort for them to follow the posts. To keep users interested in a social media page, it is important to keep the page regularly updated and at least post items once every week.

4.4.5 Website

The social media interaction can also be facilitated through a project website. By making an attractive website which is easy to use and updated on a regular basis, people are more likely to visit the website. If the website includes a forum or a discussion board users can interact with each other and with the project members.

4.4.6 Newsletter

Some projects work with newsletters, which are posted once a year (JPI Climate, CLIM-RUN), on a weekly basis (EUPORIAS, including other climate related news) or have only just begun with their newsletter (Climate-ADAPT, first newsletter February 2015). A newsletter provides stakeholders with updates on the project and can help to disseminate the latest information.

4.4.7 Video

A short video or film can be used to visualise the goals of the project and inspire stakeholders to join the project. It is easily accessible to stakeholders and it can be easily distributed by them to others. By showing lively material, animations or infographics, difficult information can be simplified for everyone to understand.

4.4.8 Teleconference

If the connection with stakeholders is made, by a form of user consultation, a follow up effort to keep users involved can be a teleconference where stakeholders are invited to a discussion by telephone. This can be a quick way of getting feedback or shortly discussing some issues.

5 PLANNING FOR THE COP MEETINGS

5.1 Introduction

A Kick-off meeting for the CoP's will be organized by ALTERRA in each city. The collected information will be presented followed by an open dialogue between potential users and the scientists involved in the project. A proposal for follow up meetings for the duration of the project will be discussed. A second round of CoP meetings will be organized by ALTERRA, including a working session on users' knowledge and operational needs and sustainable planning requirements relevant to Q_F. This will include a brown-paper session. After this session the Deliverable D.2.2 will be finalized.

This chapter describes general guidelines for the launching and the further development of the Communities of Practice. The Communities of Practice in the three case study cities most likely will not development in exactly the same way. Each community will have its own specific learning process and its own specific relationship with the URBANFLUXES researchers. Therefore, this chapter should be used as a source of inspiration that will help the researchers and stakeholders to launch and cultivate Communities of Practice in the context of the URBANFLUXES project.

5.2 Selection of participants

For the CoP we need both stakeholders from the case study cities and scientists from the URBANFLUXES project. And from both groups we need one or two leading persons, a topic champion or case study coordinator. It might concern the municipal department for sustainability / environment but this also depends on previous contacts between the researchers and the municipal government. These leading persons form a core group that helps to organize the local CoP meetings.

Table 3 shows what participants from the case studies are essential for the CoP and what kind of participants might also be invited depending on the specific problems in a city and the history of cooperation between scientists and urban organizations. The participants can be from municipal departments but may also involve the (semi) private sector, notably the energy sector.

Regarding the participation of the scientists from URBANFLUXES we expect a good representation from the local research groups in London, Basel and Heraklion. Furthermore we hope to have a representative from each work package so that all work packages get some input on the characteristics of the end users of the project. Of course the researchers from WP2, responsible for organizing the CoP's, will also be present with at least one participant.

For the second CoP meeting the set of participants may not be the same; it depends how the project will develop who is needed at such a meeting.

Table 3: Participants in the CoP from the case study cities

Core group	Essential participants	Other participants
WP2 CoP organizer Local case study leader Main contact municipality: department sustainability / environment / climate change	Energy provision sector Vegetation / green spaces Health sector Urban planning sector Operational urban management Climate change experts Geodata agency	Transport sector Construction sector Water management Architects Environmental groups

5.3 Program for a kick off meeting

The main aim of the first meeting is to create interest in the CoP. There will be results used as input in the URBANFLUXES as well but these are of secondary importance. In this CoP meeting we intend to create an open dialogue between potential users and the scientists involved in the project. Powerpoint presentations are a potential threat to such a dialogue. We have to develop other ways of interaction to maximize mutual learning in the CoP meeting. Items on the agenda might be:

- Explanation of the URBANFLUXES project based on the leaflet and interviewing Nektarios; collecting difficult questions and complex issues on a flipchart for later study;
- Photo presentation of the case study city (no text allowed) addressing basic characteristics: climate, urban structure, population. Summarize interactively what this means for urban fluxes;
- Brainstorm on heat problems now and in the future. For this, the methods of strategy and scenario development can be of use;
- Prioritize problems: most important for sustainability and well-being;
- Discuss which ones can be addressed in the URBANFLUXES project;
- Proposal for follow up meetings for the duration of the project.

The duration of the first CoP is 3-4 hours (maybe extended with an excursion/field visit).

5.4 Program for a second meeting

The second meeting has to deliver specific outputs for the project. We cannot foresee at this point what the outputs have to be. Most likely it will concern a selection of important indicators on urban heat and urban energy fluxes. The meeting will be a full day working session on users' knowledge, operational needs and sustainable planning requirements relevant to Q_F.

The method of a brown-paper session will be useful to collect a large amount of information on different topics simultaneously.

Potential items on the agenda:

- Update on the progress of URBANFLUXES and some insights on urban heat in this city;
- Explanation of the program and the needed output;
- Working sessions;
- Summary and follow up.

5.5 Practical steps towards CoP meetings

The organization of the CoP meetings require a number of steps, more or less in the following order:

- Decide for the case study city who will be the main contact for the CoP, the case study leader or someone else from the local research team;
- Make a list of participants together with the local research team, including the URBANFLUXES scientists;
- Decide on venue for the meeting; if possible at the local municipality or else at the local research institute (including catering arrangements);
- Send out a first invitation via email to the participants, signed by the case study leader, with a preliminary program (see section 5.3) and an URBANFLUXES leaflet;
- Decide who will chair and who will make notes;
- Series of phone calls to essential participants of the CoP meeting to explain what the CoP is about and make sure they will attend;
- Create final program and announce the meeting on the URBANFLUXES website;
- Send participants final invitation with an updated program and logistic information and ask them to sign up for the meeting;
- Prepare a coordinated set of short presentations;
- Hold the meeting itself;
- Prepare draft meeting report and send round to all participants for comments;

- Take care of follow up actions if these were discussed in the meeting;
- Finalize CoP meeting report and send round.

6 MONITORING THE LEARNING PROCESS OF THE COP MEETINGS

6.1 Why monitor the CoP's?

Although many projects nowadays make an effort to involve stakeholders, it is often not clear to what extent these projects have succeeded in reaching the intended groups (Groot et al, forthcoming). This aspect is often not systematically evaluated.

Monitoring is considered as the regular collection and analysis of information and data to provide a basis for valuing the outcome of the Community of Practice.

It is important that the community members, including the community coordinator, are aware of the learning process they are going through. Communities need to monitor and value their performance to know how they are doing and to guide ongoing efforts to become more vibrant and effective. Monitoring the community's learning process can reinforce members' participation and provides a basis for adapting approaches and prioritizing activities.

The people who will use the monitoring results are predominantly the community members, including the community coordinator. Community coordinators might want to know what methods and tools were effective. Community members might be interested in the value of the outputs of the community for the overall project.

6.2 What data to collect, how and when?

A common pitfall in monitoring learning processes is that many data are collected without being used. Data collection is costly, therefore, it is important to consider carefully what data and information the community (and other stakeholders) need to improve the functioning of the community. The monitoring should support decisions on, for example, what activities to undertake, who else to involve, how to facilitate the interaction between the members, and how to manage conflicts.

The monitoring design involves identifying what data need to be collected, how and how often. Experience shows that the more community members are involved in deciding what to monitor, the more they will use the monitoring results and as such, the more the monitor will serve as a learning tool. In Table 4 we will give some examples of what could be monitored in the context of the URBANFLUXES project.

Table 4: Examples of what aspects of the CoP learning could be monitored

Possible issues	Possible indicators and questions	Methods /tools
Domain	To what extent is urban heat a shared concern? To what extent can 'urban heat' be regarded as the domain of interest of the community? Has a learning agenda been defined? If yes, what's on the learning agenda? To what extent has a sense of identity been developed by the community? To what extent has the domain been adapted in the course of the process?	Observations during meetings of the community Interviews and informal talks with community members
Community	Who are the members of the community and what is their background? Why have they decided to become a member? How often do they interact? To what extent do the members feel connected to each other? Have common stories or "inside" jokes been developed? To what extent do the community members give suggestions on what to discuss in a next gathering? Do the community members meet each other informally beyond the formal meetings?	Observations during meetings of the community Interviews and informal talks with community members
Practice	What practical issues in relation to urban heat do the members discuss? What practical issues do the members want to	Observations during meetings of the community

	learn about jointly? (Procedures, skills, decision making etc.) To what extent are the community members using the new procedures /tools/techniques?	Interviews and informal talks with community members

6.3 First interview round

At the start of the project, a first interview round will be held among the projects researchers to collect their expectations of the CoP's and their views on the URBANFLUXES project at the first stage. See Table 5 for the interview questions.

Table 5: Interview questions first round

Interview questions
1. What practical problems is URBANFLUXES about? 2. What is the added value of Earth Observation data for cities? 3. What do you expect the project to deliver to the case study cities during its course? 4. What kind of knowledge do you have now that is already useful for the case study cities? 5. What can other project partners offer to them right now? 6. Do you see a difference between the three cities in what would be useful for them? 7. What can we promise them safely? What should we not promise them? 8. What should be the message of the first film? 9. What kind of departments or expertise should we invite to participate in the project?