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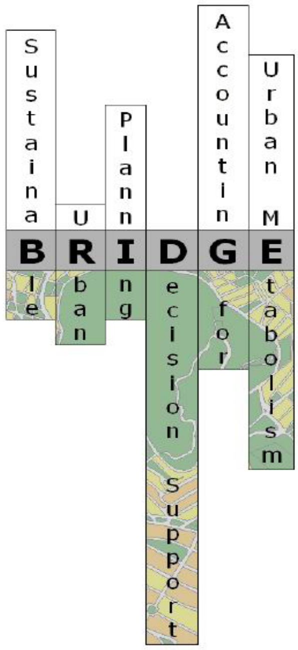
Issue 4

BRIDGE newsletter



Editorial

The FP7 project BRIDGE** (sustainaBle uRban plannIng Decision support accountinG for urban mEtabolism) is a joint effort of 14 European Organizations aiming at incorporating sustainability aspects in urban planning processes, accounting for some well recognised relations between **urban metabolism** and **urban structure**. BRIDGE was launched in 2008 in order to **assist urban planners to present and evaluate planning alternatives towards a sustainable city.

As the project evolves towards its conclusion, the 4th issue of the newsletter provides a more complete picture of its achievements so far. Emphasis is being put on the presentation of the first Prototype of the BRIDGE Spatial Decision Support System. The aim of the system is to assist decision making by providing an assessment of alternatives and methods for the urban environment linking biophysical processes with socioeconomic parameters. The foresight exercise that was held in the framework of the project is also described in this issue. Other articles which demonstrate the progress and findings of the project regarding the models' simulations and results for case study cities as well as the sustainability of planning alternatives are also included in this issue.

BRIDGE partners:

1. Foundation for Research and Technology - Hellas (FORTH), Greece
2. King's College London (KCL), United Kingdom
3. Consiglio Nazionale delle Ricerche (CNR), Italy
4. Instytut Ekologii Terenów Uprzemysłowionych (IETU), Poland
5. Technical University of Madrid (UPM), Spain
6. University of Aveiro (UAVR), Portugal
7. University of Basel (UBAS), Switzerland
8. Trinity College Dublin (TCD), Ireland
9. University of Helsinki (UHEL), Finland
10. National and Kapodistrian University of Athens (NKUA), Greece
11. Centro Euro-Mediterraneo per i Cambiamenti Climatici S.c.a.r.l. (CMCC), Italy
12. Météo France Centre National De Recherches Météorologiques (CNRM), France
13. DLO/Alterra B.V. (ALTERRA), The Netherlands
14. University of Southampton (SOTON), United Kingdom

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Introduction

BRIDGE aims at illustrating the advantages of considering environmental issues in urban planning and focuses on specific urban metabolism components (**energy**, **water**, **carbon**, **pollutants**). BRIDGE integrates the development of numerical tools and methodologies for the analysis of fluxes between a city and its environment with its validation and application in terms of future development alternatives, based on environmental and socio-economic indicators for baseline and extreme situations. Therefore, the innovation of BRIDGE lies in the development of a **Decision Support System (DSS)** integrating the bio-physical observations with socio-economic issues. It allows end-users to evaluate several urban planning alternatives based on their initial identification of planning objectives. In this way, sustainable planning strategies will be analysed based on quantitative assessments of energy, water, carbon and pollutants fluxes.

BRIDGE involves five European cities as case studies: a high latitude with rapid urbanization city that requires a substantial amount of energy for heating (Helsinki, Finland); a low latitude Mediterranean city that requires a substantial amount of energy for cooling (Athens, Greece); a representative European megacity (London, United Kingdom); a representative European old city with substantial cultural heritage (Firenze, Italy) and a representative Eastern European city with dynamic planning process reflecting the economical, social, and political changes held within last two decades (Gliwice, Poland).

The project so far

The inclusion of sustainability objectives in urban planning, providing the opportunity for the incorporation of the knowledge from the bio-physical sciences into the planning process, is becoming a necessity. To this end the BRIDGE Project aims to develop a DSS reflecting the multidimensional nature of the urban metabolism, through operational indicators, that may be easily comprehended by a non-specialized and scientific audience.

The BRIDGE Project, being at its third year of action, has progressed in a way that reflects the achievement of the objectives and technical goals in a very satisfactory way.

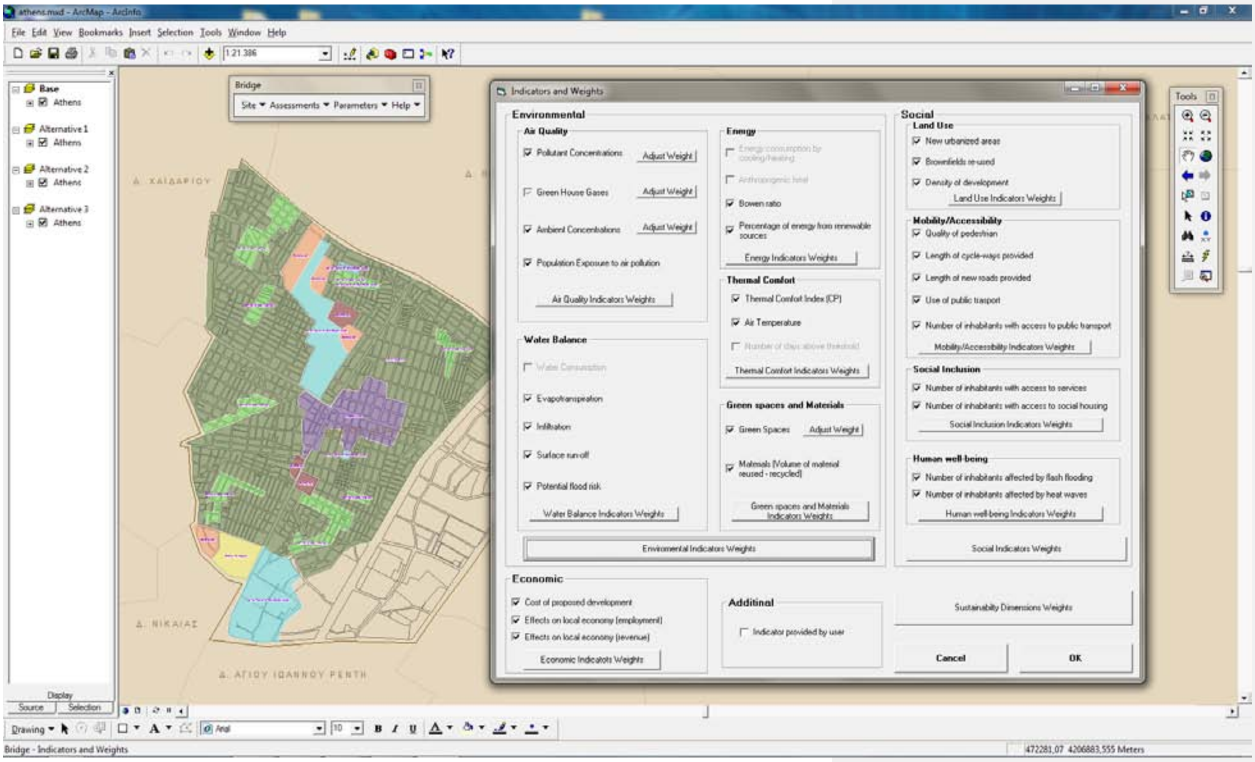
The research performed in the framework of BRIDGE has been multidisciplinary. The role of land use in relation to urban patterns and typology has been assessed using remote sensing data from flight campaigns or satellites. The urban metabolism components fluxes have been measured and modeled at local scale and their spatial distributions have been estimated. Observational data have been used for the validation of the different mathematical procedures in order to assure that different methods and interactions reflect the actual situations. Socio-economic data have also been collected with the support from local authorities in all five case study cities.

The BRIDGE database has been developed and is constantly being updated with all the available data. Collected data has been used to parameterize the environmental models, which in turn provide spatio-temporal distributions of physical parameters, used to estimate sustainability indicators, addressing the state of the urban environment.

The indicators to be used in the BRIDGE DSS have been decided through a "Community of Practice" approach after several discussion and feedback from possible end-users. Two rounds of "Community of Practice" meetings, were organized in all the BRIDGE case studies, where local decision makers and scientists exchanged their knowledge and experience with sustainable urban planning. This way, it was the end users that that decided on the urban planning priorities and the sustainable objectives that correspond to their needs and determine the objectives' relative importance. During the lifetime of the BRIDGE Project, there has been a continuous and productive exchange of ideas and experiences between involved stakeholders that has built a strong network, accomplishing the effective support of the project.

A simulation of the BRIDGE DSS took place during the Foresight Exercise that was organized in London, in December 2010. This workshop was attended by experts in the field of urban planning from all case studies and other experts (both from BRIDGE consortium and from other organization) on different aspects of urban sustainability. The data collected during this exercise (different sets of weights, and tests of the sensitivity of multi-criteria formulae) has been useful for the development of the DSS Prototype.

The first version of the BRIDGE DSS Prototype is currently available. This version of the DSS Prototype include: a) the database holding the collected data (vast amount of data both environmental and socio-economic), b) "online models" for the necessary simulations and (c) a Graphical User Interface (GUI) with a two- fold role. First, to operate in a user friendly manner for the users to select the criteria and indicators to be used in the analysis, while at the same time defining their relative importance. And second, to be used for the presentation of the analysis results.



The first version of the BRIDGE DSS Prototype.

The BRIDGE DSS Prototype will be demonstrated in the BRIDGE Sustainable Urban Planning Conference to be held in Brussels on the October 26, 2011. Apart from demonstrating the BRIDGE DSS, this conference also aims at bringing together urban planners, municipal politicians, architects, property developers, urban professionals in water management, public works and environmental management, consultancy firms, EU policy makers and scientists; facilitating exchange of ideas and experience between urban planners and BRIDGE researchers regarding sustainability issues and to increase participants understanding about the integrated character of urban metabolism and its role in urban planning.

BRIDGE Sustainable Urban Planning Conference

This conference aims at…

…bringing together urban planners, municipal politicians, architects, property developers, urban professionals in water management, public works and environmental management, consultancy firms, EU policy makers and scientists;

…facilitating exchange of ideas and experience between urban planners and BRIDGE researchers regarding sustainability issues and to increase participants understanding about the integrated character of urban metabolism and its role in urban planning;

…providing hands on experience with new tools (e.g. the BRIDGE Decision Support System (DSS) that has been developed within the project) supporting sustainable urban planning.

The agenda includes presentations from invited speakers, experts on urban planning and sustainable landscape strategies, with focus on the BRIDGE perspective. A poster session on urban metabolism and sustainability topics is included along with the workshop on BRIDGE DSS.

Place and date
Brussels,
October 26, 2011

Contact
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(bjoern.lietzke@unibas.ch).

Project meetings and upcoming events

Although the communication between the project participants is almost daily via email, via Skype or via the ftp web based server, there was also an Extended Management Board meeting in Brussels on 14 June 2010 in order to resume the basic points to be presented in the Mid-term review meeting.

On the 8th of December, a foresight exercise was organized in London, with the presence of experts from the case study cities and some international and BRIDGE experts on several dimensions of urban sustainability.

A very important meeting for the Project, the 4th Progress Meeting was successfully organized by FORTH and KCL in London, on December 9-10, 2010. It was attended by 34 persons. Members of the BRIDGE Advisory Committee were also attending the 4th Progress Meeting. WP leaders presented the progress of WPs 3, 4, 5 and 6 and discussion followed to evaluate the progress of the project. An Action List was developed for the fourth semester of the project (until the 5th Progress Meeting to be held in Gliwice in May 2011). All WP leaders (except WP2 and WP5 that have already concluded) presented the WPs progress since the beginning of the project and especially during the last semester. Action plans for the next semester were discussed. In the framework of the 4th Progress Meeting, the 5th Steering Committee and the 3rd Advisory Committee Meetings took place in London.

One Management Board Meetings (12th MB Meetings) was organized by FORTH through Skype during the 9th RP. All Management Board members were represented in those meetings. There is constant communication between the partners and the Action List developed during the 4rd Progress Meeting was followed.

One of the most important late events of the Project were the 5th Progress Meeting, which was held in Gliwice, on May 24-25, 2011 and the BRIDGE Overview presentation update which was performed by the Work Package Leaders on 8 July 2011.

Upcoming events of the Project are: the FP7 Coordinators Meeting to be held in Brussels on July 12-13 2011, the DSS Final Evaluation Meeting to be held in Heraklion, Crete, on 30 September 2011, the Demonstration event to be hosted by ALTERRA on 26 October 2011 and the Final MB Preparation Meeting and Final Review Meeting to be held in Brussels on 23 and 24-25 November respectively.

A detailed description of the tentative plan for the 26 October event is included in the articles' area.

The First Prototype of the BRIDGE spatial Decision Support System

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Foundation for Research and Technology – Hellas

Introduction

Decision Support Systems (DSS) have the potential to support complex decision making and solve semi-structured or unstructured problems through a computer interface that presents results in a readily understandable form. Since the early 1970s, DSS technology and applications have evolved significantly enabling far more powerful database, modelling and user interface. Since early '90s all aspects of Geographic Information Systems (GIS) were recognized in some way to assist with decision making and effectively provide support in planning decisions. Today, the basis of geospatial decision support is the GIS technology. The basic support of GIS in decision making includes data management to extend human memory, graphic display to enhance visualization, and spatial analysis functions to extend human computing performance. Beyond these common aids, special features of GIS include modelling, optimization, and simulation functions required to generate, evaluate, and test the sensitivity of computed solutions. Other functions, such as statistical, spatial interaction, and location/allocation models, are also supported by GIS software. Such decision support models that are linked to environmental models and decision making models often called spatial decision support systems and are used for evaluation of land planning decisions (planning support systems) [1].

The main aim of the BRIDGE DSS is to assist decision-making by providing a structured assessment of alternatives and methods for the comparative analysis, ranking, and selection among them. The problem with selecting options is always that options depend on the objectives that the decision-maker states (user). The objectives are usually conflicting, and therefore, the solution must be seen as the trade-off between a number of objectives which in turn depend on the preferences of the decision-makers. The main function of the BRIDGE DSS is to provide the tools for the evaluation of alternatives based on key urban metabolism components (environmental, social and economic).

Design and Architecture

The BRIDGE DSS is based on an analytical and a design component, linking the bio-physical processes in urban environment with socio-economic parameters. The DSS estimates the trade-off between the environmental and the socio-economic dimensions of changes in the urban metabolism introduced by urban planning actions.

The analytical component supports the assessment of the environmental impacts of the energy, water, carbon and pollutants fluxes and the environmental impact of urban metabolism for given urban structures and given levels of resource use is addressed. The physical flows are identified using numerical modelling and a set of indicators, related to the urban sustainability objectives, is identified. The design component offers tools to assess the environmental and socio-economic impact of different planning alternatives. The planning alternatives are practically modifications of land-use and resource and therefore modifications of the metabolism of the urban system. The link between the analytical and the design components is a multi-criteria evaluation module to supplement decision support capabilities. This module combines the environmental with the socio-economic aspects of urban metabolism and evaluates the performance of each planning alternative in terms of sustainability.

Database

During the BRIDGE project a great amount of environmental and socio-economic data was collected. Energy, water, carbon and pollutants fluxes are systematically monitored in-situ and via remote sensing in the BRIDGE case studies: Helsinki-Finland, Athens-Greece, London-United Kingdom, Firenze-Italy, Gliwice-Poland. Surface fluxes and latent heat, momentum, net urban carbon exchange and aerosols fluxes are measured by eddy covariance/large aperture scintillometry on a continuous basis and repeated seasonal campaigns of research aircrafts. Satellite, airborne and ground-based remote sensing data and methodologies were used to provide the required spatio-temporal distributions and maps of physical parameters, as well as to produce suitable derived indices. The land cover/use dynamics were also estimated and mapped.

Socio-economic data are being also collected and organized in GIS databases concerning: space; mobility; heat and water demand; land-use types, coverage and intensity; building volumes; population density; unemployment rate; education level. Spatial analysis techniques are employed to analyze and harmonize these datasets.

In addition, spatial distributions of physical parameters were produced using environmental modeling. Different types of model simulations have also been conducted in BRIDGE project, from mesoscale air quality model simulations to urban canopy model simulations, producing a vast amount of data. The cascade modeling technique from large to local scale is the main methodology applied in BRIDGE. This approach allowed estimating the pollutant concentrations and the fluxes associated to varying geographical extents of urban development scenarios. Mesoscale meteorological models were used to simulate the atmospheric flow in a 3D cube with spatial resolutions on about 0.2 - 100 km with domains between 10 km and 50 km to thousands of km. These models gave detailed information of all meteorological variables and fluxes involved in the atmospheric flow and provided input to chemical transport models.

The spatial data were organized in a geo-database. GIS procedures applied to elaborate the digital maps contained in this database. The spatial entities were stored in the system; however, the various attributes associated with each spatial object were stored in a Relational Database Management System (DBMS) to meet the requirement that the GIS should be able to operate transparently with the RDBMS system selected. Standard Open Database Connectivity (ODBC) drivers were used to allow the communication between GIS and DBMS.

Graphical User Interface

The BRIDGE DSS Graphical User Interface (GUI) is developed in Visual Basic as a Dynamic Link Library connected to ArcGIS software. The role of the Graphical User Interface (GUI) of the BRIDGE DSS is twofold. On one hand, the GUI is used to make easier for the users to select the criteria and indicators to be used in the analysis as well as define their relative importance. On the other hand, the GUI is also used for presentation of the analysis results.

In order to run an assessment the following steps should be done:

- Choose a case study to work with
- Choose the indicators to be used in the assessment
- Assign weights to the indicators
- Provide user-defined indicator values (those that are not provided by the models)
- Run the assessment procedure
- View the results

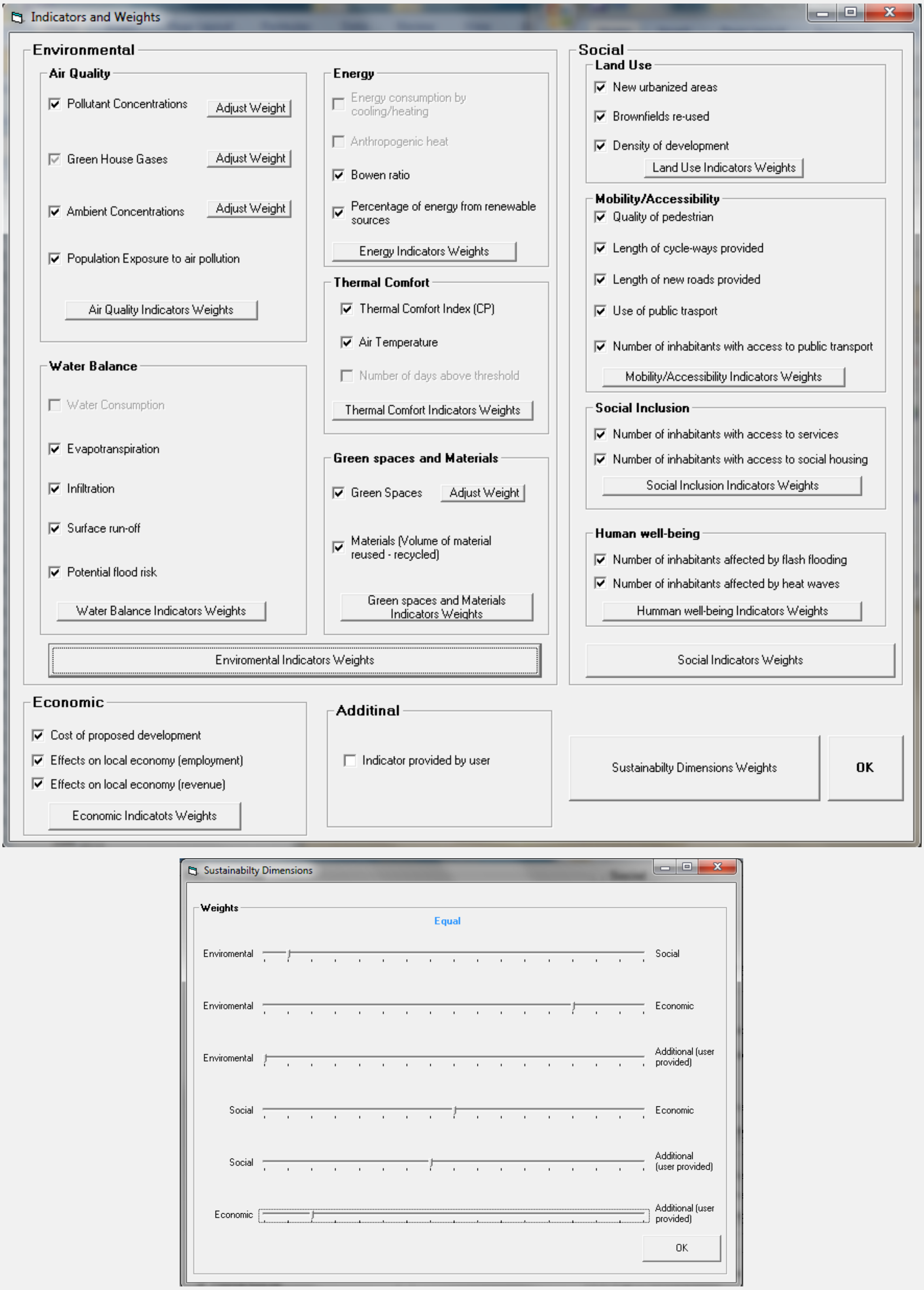

Figure 1. a) The Indicators and Weights menu. The indicators that are used in BRIDGE to assess urban metabolism are presented in a window. b) The Weighting Sustainability Dimensions menu. By scrolling the bars weights are assigned to the respective sustainability dimensions.

The BRDGE DSS Prototype to be developed from the BRIDGE Project will be available for the five BRIDGE case studies (Helsinki-Finland, Athens-Greece, London-United Kingdom, Firenze-Italy, Gliwice-Poland). The first step of the sustainability assessment procedure is to define the desired case study.

The next step of BRIDGE DSS parameterization is to define the indicators to be used in the analysis. The indicators that are used in BRIDGE to assess urban metabolism are presented in a window, as shown in Figure 1a). The user is asked to select which ones to include in the analysis by checking the respective boxes. The indicators are grouped according to sustainability objectives: Air Quality, Water Balance, Energy, Thermal Comfort, Green Spaces and Materials, Land Use, Mobility/Accessibility, Social Inclusion, Human well-being, Cost of proposed development, Effects on local economy. The potential of adding a new indicator is also given to the user, considering that the user has the required data to support this new indicator.

As a next step the user has to assign weights to the indicators. The pair-wise comparison technique is used to define weights [2]. The essence of the process is decomposition of a complex problem into a hierarchy with a goal at the top of the hierarchy, criterions and sub-criterions at levels and sub-levels of the hierarchy, and decision alternatives at the bottom of the hierarchy. Elements at a given hierarchy level are compared in pairs to assess their relative preference with respect to each of the elements at the next higher level. The verbal terms of the Saaty's fundamental scale [2] shown in Table 1, is used to assess the intensity of preference between two elements. Ratio scale and the use of verbal comparisons are used for weighting of quantifiable and non-quantifiable elements.

Figure 1b) shows the weighting menu of the three urban metabolism components (sustainability dimensions). In the example of Figure 1b) the Environmental Sustainability Dimension is considered *greatly more important* than the Social Sustainability Dimension, according to the verbal terms of Table 1.

Table 1. Scale value meanings for pair-wise comparison.

	Relative Importance
0	equal importance
1	slightly more important
2	weakly more important
3	weakly to moderate more important
4	moderately more important
5	moderately to strongly more important
6	strongly more important
7	greatly more important
8	absolutely more important

Following the same procedure, similar menus to Figure 1b) appear for all the elements in the indicators hierarchy. If no weights are assigned by the user to a group in the hierarchy, the respective elements of the group are considered of equal importance.

Although the BRIDGE database contains a large amount of data from which most of the indicators values are derived, some indicator values need to be defined by the user. The user-defined indicator values are provided using the window shown in Figure 2.

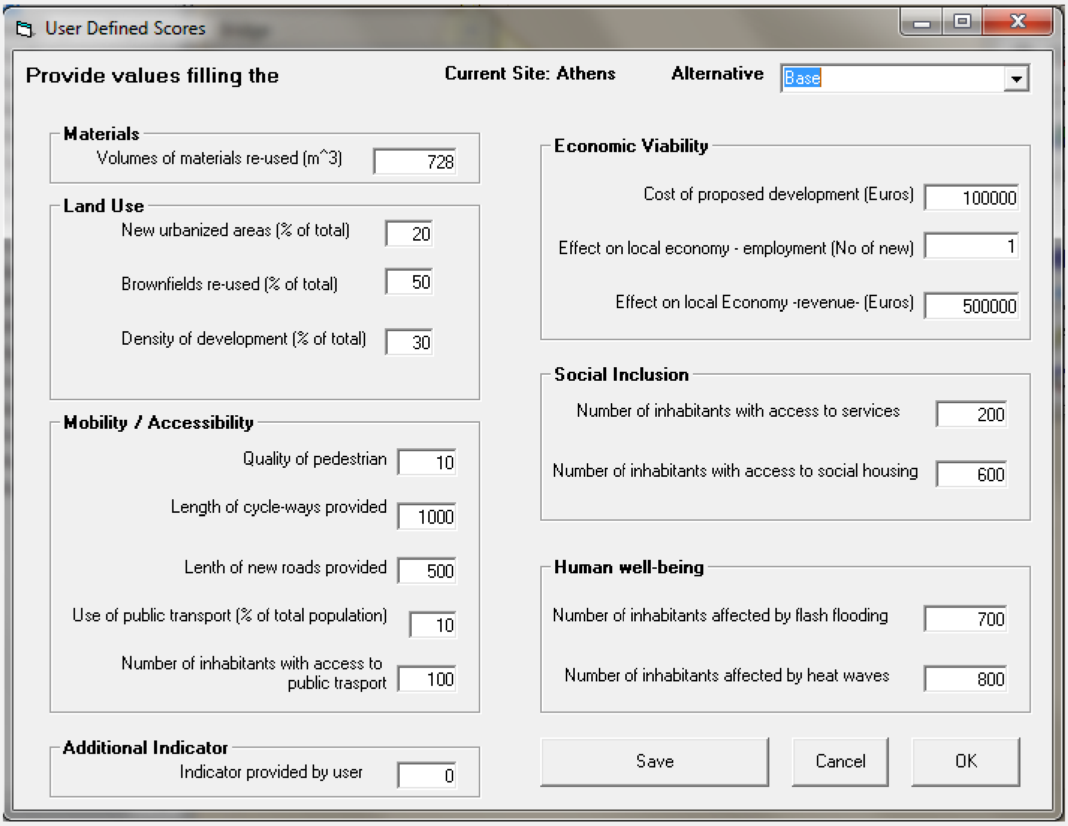

Figure 2. The user-defined indicators values window.

After all the required parameters have been set, an assessment can be run to evaluate the different planning alternatives. The final appraisal scores that were computed for the planning alternatives are presented to the user. A break-down of the scores that were computed for the selected sustainability objectives are presented in a form of a spider diagram, like the one shown in Figure 3. A spider diagram reflects successfully the relative importance of the selected objectives.

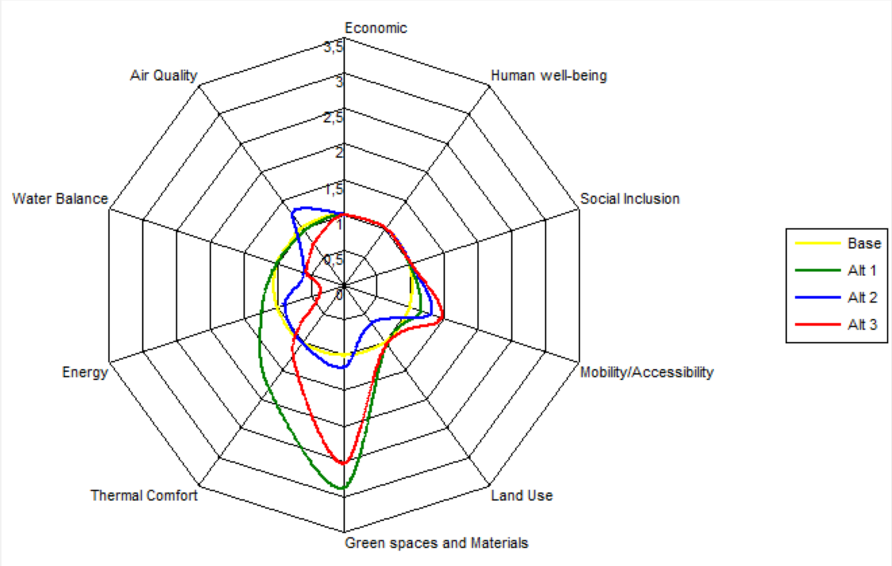

Figure 3. Result of the BRIDGE DSS assessment. Scores computed for all sustainability objectives are presented in a form of spider diagram.

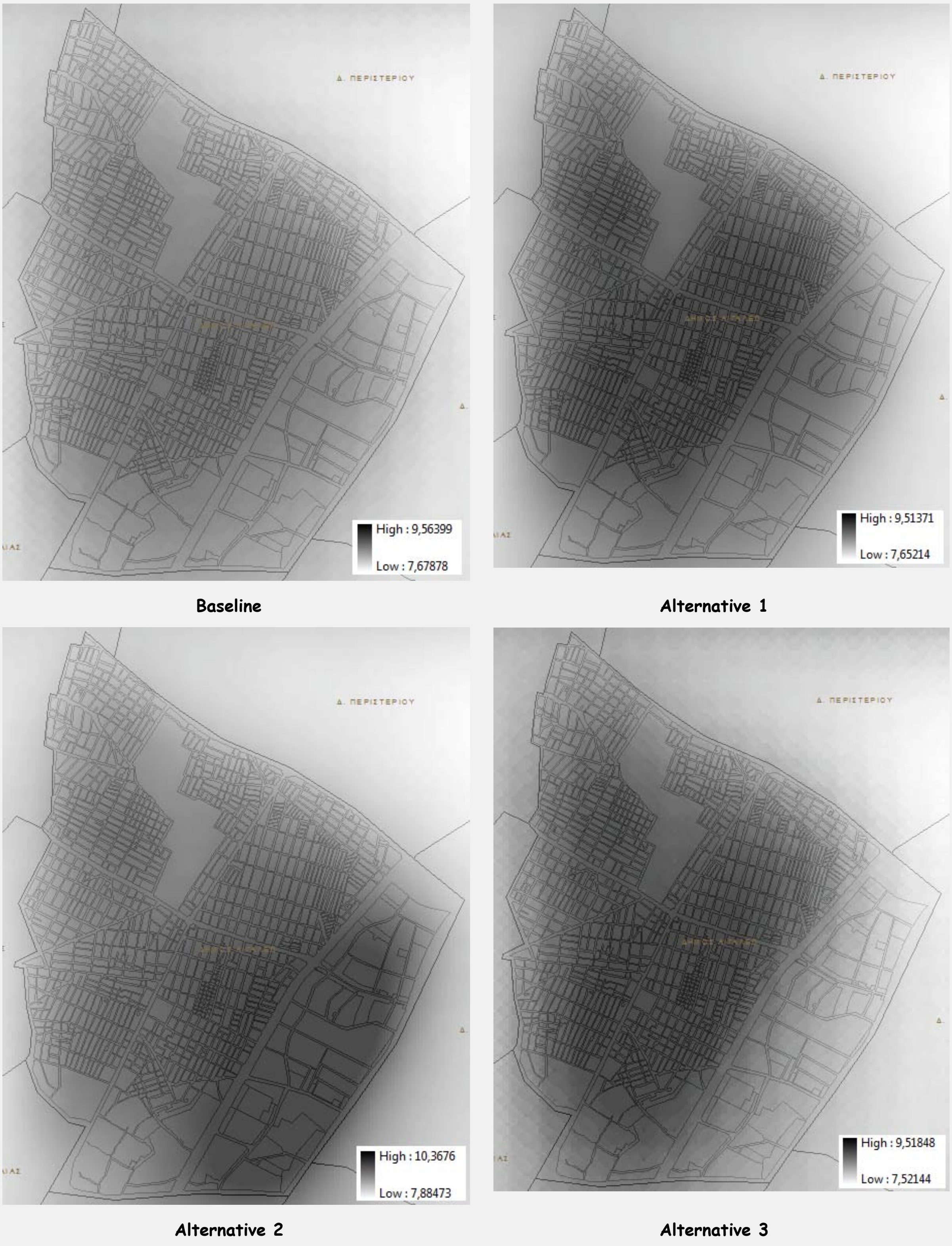

Figure 4. Example of produced indicators maps. This figure presents the spatial distribution of mean PM10 concentration for 2008, over the Egaleo case study area in Athens

In addition to the final appraisal score and the spider diagram the user has the opportunity to produce different kinds of indicators spatial distributions. Maps of mean, min, max and sum values over a time span can be produced for each planning alternative. The user selects the time span Figure 4 shows the spatial distribution of mean PM_{10} concentration for 2008 for the case study of Athens (Egaleo area).

Conclusions

Although, several studies have addressed urban metabolism issues, only a few have integrated the development of numerical tools and methodologies for the analysis of fluxes between a city and its environment, its validation and application in terms of future development alternatives, based on environmental and socio-economic indicators. The innovation of BRIDGE lies in the development of a Decision Support System (DSS) which integrates bio-physical observations with socio-economic concerns. The DSS is GIS-based, therefore GIS tools and techniques are used to integrate all datasets, analyze the various spatial entities, prepare the input for the physical flows models and the decision making models, store the results and then visualize them.

The BRIDGE DSS evaluates how planning alternatives can modify the physical flows of specific urban metabolism components. The evaluation of the performance of each alternative is done according to the relative importance ascribe to each objective by the user. Objectives are characterized by indicators, organized in criteria. The combined performance of all indicators selected as relevant in each particular case are used to rank planning alternatives. The DSS therefore allows users to evaluate several urban planning alternatives based on previously defined sustainability objectives. The tool aims at promoting sustainable planning strategies by informing and enhancing planning processes through the quantitative assessments of environmental aspects (e.g. energy, water, carbon and pollutants fluxes) on a pair with socio-economic considerations.

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Integrated air quality modelling: a new URBAIR version

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With the aim of simplifying the integration of URBAIR (Urban Air Quality) model into BRIDGE's DSS, and improving the capability and user-friendliness of this tool, a new version was developed. One of the advantages of this improved on-line model is that it integrates a number of functionalities, namely the estimation of road traffic emissions, the description of meteorological conditions and geographical characteristics (terrain, buildings and sources location), which will then be used to simulate the dispersion within the study area. The new version also includes a series of other pre-processors that prepare the input data namely in terms of format to use by the model. This structure is organized into 4 modules as schematically shown in Figure 1.

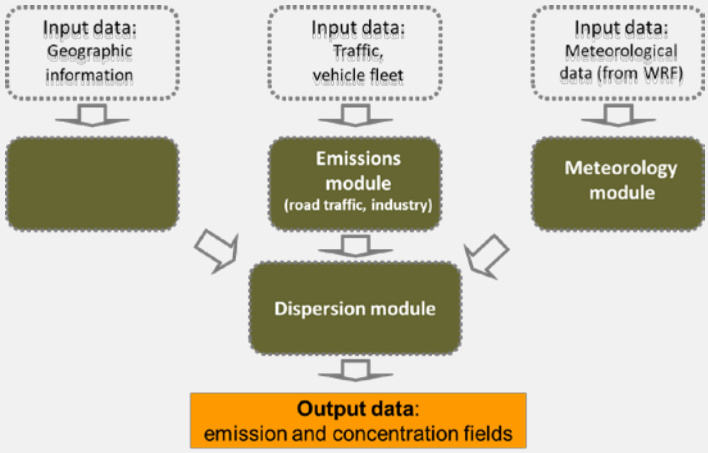


Figure 1. URBAIR integrated version.

Traffic flux emissions are calculated with the Transport Emission Model for Line Sources (TREM) [1], while dispersion is modeled applying an improved version of the second generation Gaussian model POLARIS, also developed by the UAVR team [2]. This model is significantly different from traditional Gaussian dispersion models, because considers the presence of buildings during the dispersion simulation and its dispersion parameters have a continuous variation with the atmospheric stability. The model is suitable to be used for distances up to about 10 km from the source. The model is a steady state atmospheric dispersion model, based on boundary layer scaling parameters, such as the Monin-Obukhov Length instead of relying on Pasquill-Guifford stability classification. A pre-processor calculates the meteorological parameters needed by the dispersion model, namely the atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov Length and surface heat flux. Furthermore URBAIR requires meteorological information that is provided by the mesoscale meteorological model WRF. Alternatively if surface measurements and upper air soundings databases are available they can also be used.

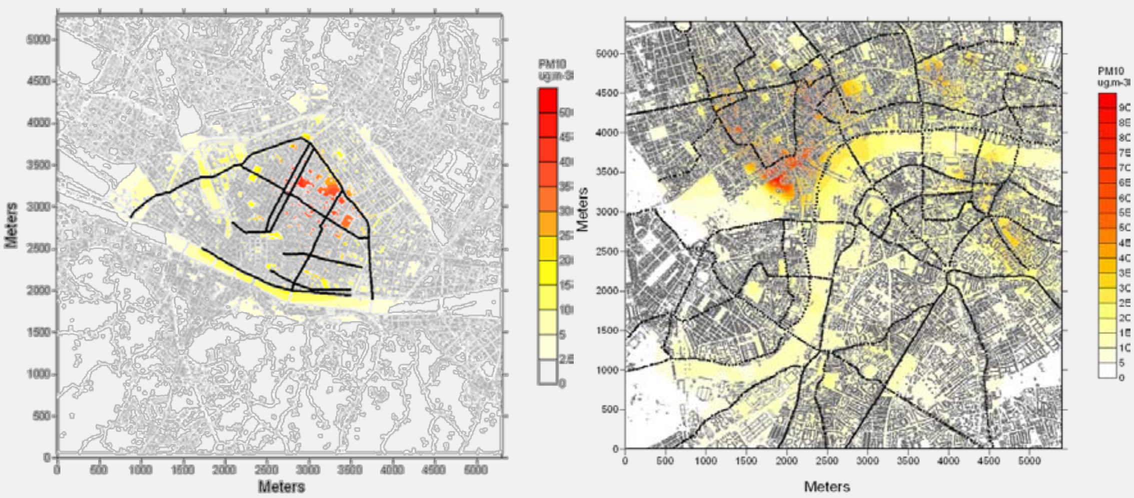
URBAIR requires also the characterization of topography, land-use, and buildings (location and dimensions), usually provided by GIS maps.

Terrain surface, topography and build-up structures characteristics have a significant influence on the dispersion behavior of atmospheric pollutants, in particular in urban areas. With this assumption, the terrain module is implemented in URBAIR model to process spatial variation of terrain surface elevation and nearby built-up areas characteristic parameters required by URBAIR. In order to consider actual Geographical Information System (GIS) tools formats or other types of information, this module relies on a Cartesian coordinate system in which, regular and discrete gridded data can be used to characterize and spatially distribute terrain, receptors and sources. Representative terrain-influence heights and 'projected' building structures influence are determined following widely used modelling approaches. Topography is specified in the form of terrain heights at receptor locations. The influence of buildings on hazmat gas dispersion depends on the orientation of the building with respect to the source, the wind direction and the shape of the building. Direction-specific downwash parameters, in the form of projected building height and width dimensions, are estimated using the EPA's Building Profile Input Program PRIME (BPIP-PRIME) modelling approach [3].

One of the major improvements attained with this new integrated URBAIR version was the coupling with The TREM model, a road traffic emission model was developed at the University of Aveiro to support the estimation of atmospheric pollutants emissions induced by road traffic with high temporal and spatial resolution, to be used as an input data tool in local and urban on air quality management and modelling issues [1]. The model provides emission data, an important input to dispersion models, health effect analysis, impact studies and Air Quality Management. The TREM algorithm is based on the emission functions derived from the MEET/COST and state-of-the-art EMEP CORINAIR [4] emission factors for current and near future road vehicles technologies. The following pollutants are covered: carbon monoxide (CO), nitrogen oxides (NOx (given as NO_2 equivalent), sulphur dioxide (SO_2), volatile organic compounds (VOC), carbon dioxide (CO_2), and particulate matter in the form of $PM_{2.5}$ and PM_{10} (particles with less than 2.5 μm and 10 μm in aerodynamic diameter, respectively). Besides the estimation of road transport emissions, the model calculates the fuel and energy consumption.

The output data from new URBAIR version includes the meteorological parameters and pollutant concentration at user-specified receptor points or spatially distributed over a regular grid. Different mean averaged concentration values can be defined, depending on the purposes.

The URBAIR model has been tested for several study cases. Some of the results are presented in Figure 2; the figures present the model simulations results (24 hour mean averages) for Florence and London study cases for a particular day.



a) b)

Figure 2. URBAIR integrated version application for baseline scenarios for (a) Florence (9 January 2008) and (b) London (7 November 2008).

As an example, in the Helsinki domain, with a resolution of 4000x4000 m^2, 250 buildings and 1411 emission sources, the CPU running time is approximately 2 hours for the simulation of 1 month in a typical PC with a 32 bit operating system. URBAIR is also available in a 64 bit version which is able to simulate a much higher number of sources.

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Impact Assessment Model: Sustainability of Planning Alternatives in BRIDGE

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1. Introduction

The methodological framework for the assessment of the planning interventions has the overall goal of increasing the sustainability of urban metabolism in the BRIDGE case studies. The final scope of the assessment methodology is to assist CoP members (or future DSS end-users) to better explore the decisions at hand; and to analyze the trade-offs between the competing criteria (i.e. the degrees to which the planning alternatives meet the predefined sustainability objectives, based on the defined sustainability indicators).

To achieve this, the methodology is based on the key principles of environmental assessment (as per the legislative requirements of the Strategic Environmental Assessment Directive 2001/42/EC and the Environmental Impact Assessment Directive 97/11/EC). Environmental assessment processes are facilitated by the development of socio-economic and environmental indicators against which planning interventions can be assessed. Such indicators are also utilized to monitor progress towards established sustainability objectives or to evaluate changes in officially set environmental quality targets/thresholds.

Given that land use plans are intrinsically spatial (i.e. commonly link land use to location), spatial evidence and spatial approaches can significantly benefit plan-making. Spatial tools such as Geographic Information Systems (GIS) can support the integration of socio-economic and environmental considerations by providing evidence of relevant socio-economic, environmental and planning considerations, and raising awareness of the spatial implications of a planning intervention. Moreover, they can be combined with external modelling tools to predict likely future socio-economic and/or environmental conditions, based on the characteristics of the planning alternatives.

In the light of the above, the DSS developed in BRIDGE avails of GIS to integrate multiple qualitative and quantitative socio-economic and environmental spatial datasets and combine them with the spatial results of modelling operations. The methodology is based on Multi-Criteria Assessment (MCA) techniques, whereby each spatial dataset is weighted according to end-user or public values, prioritising parameters (i.e. criteria and/or indicators) according to planning or policy priorities for a given urban context and, thus, ensuring a transparent and participative approach to the sustainability assessment of urban planning alternatives.

2. Methodological Framework

The methodological approach to the assessment of planning alternatives in the BRIDGE DSS can be subdivided into a number of steps (Figure 1), which follow a decision-making logic and apply a MCA approach to impact assessment. Due to the nature of the DSS, and to the specific requirements in terms of definition of objectives, criteria and weights, the assessment is an interactive process where the end-user selects from multiple choices shaping the assessment criteria.

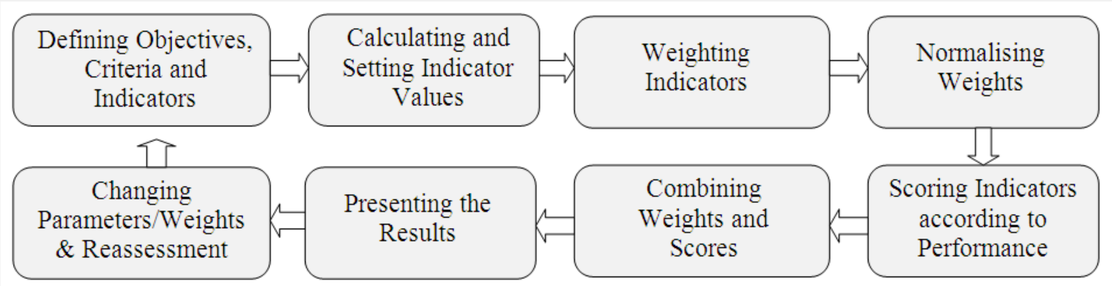

Figure 1. Flow-diagram illustrating the steps of the impact assessment methodology in the BRIDGE DSS.

The first step requires the end-user to define the sustainability objectives (e.g. improve air quality), criteria (e.g. PM_{10} threshold/limit set by EU legislation) and indicators (e.g. concentration) that are applied in the assessment of planning alternatives. This selection is commonly based on the policy objectives or planning priorities for a given urban context. As these issues have been explored during the relevant CoP meetings, key sustainability objectives, criteria and associated "core" (i.e. common to all case studies) and "discretionary" (case-specific) indicators provide a starting point in the BRIDGE DSS to the end-user. Although the end-user selects the relevant objectives and indicators from a list embedded in the DSS, additional sustainability objectives and indicators can also be added if relevant, and assuming indicator values are available (addressing the model and data limitations within the project).

Indicator values are then provided for each alternative. Where the indicators can be modelled within BRIDGE, the values for the indicators selected are automatically provided to the end-user as a modelling output. The results of the models are displayed in both spatial and numerical (average) form. Therefore, the DSS displays the spatial distribution of the values for a given indicator within the study area in the form of a GIS map. This is considered vital information for the end-user to contrast, for example, different building layouts within the development area and adjust them according to any identified land use conflicts or impact distribution patterns. Similarly, the value for the area is spatially averaged to obtain an overall value for that indicator and, thus, facilitate its aggregation with the non-spatial indicators.

The performance of indicators is automatically scored based on how close the indicator value is to a reference basis (i.e. criteria). When assessing the performance of indicators, targets/thresholds are used as reference points to establish the nature of the indicator's performance. Thresholds refer to the maximum value permitted according to European and national legislation (i.e. upper benchmark such as the 50 $\mu g/m^3$ limit for PM_{10}). In some instances, targets are applied referring to the minimum value the indicator should have (i.e. lower benchmark such as a minimum of 68% of employment).

Once indicators are selected and their values (and performance score) defined, the end-user is requested to perform a pair-wise comparison of the relevant indicators (applying Analytical Hierarchical Process MCA). Each indicator is contrasted against another and the end-user is prompted to determine which one is more important/significant. As a result, the indicators are weighted according to their importance/significance set by the end-user and based on the sustainability goals (or planning priorities) for the city or other considerations of subjective nature. This results in indicator weights, which enable the integration of end-user perceptions into the assessment.

Finally, the total performance for a given alternative is calculated as a function of the total indicators' scores and weights. The relative importance of each indicator (i.e. weight) is combined with the indicator scores to obtain the performance index that enables an overall comparison of alternatives.

The results are presented in a comprehensive manner, including both spatial and non-spatial information:

- GIS maps available for the spatial-indicators;
- Mean, maximum or minimum values for the study area for spatial indicators;
- Absolute indicator values for the non-spatial indicators;
- Spider diagram combining the indicator results for each objective or criterion; and
- The total assessment value (or performance index) for each alternative.

The reason behind the provision of a set of results is that the methodology adopted in the BRIDGE project aims to inform/support decision-making (i.e. not to make decisions), with the premise that the more information is provided the more informed the decision. Based on the results, the end-user or decision-maker can make an informed decision on the suitability of alternatives by looking at how the different alternatives affect the socio-economic and environmental components of the urban context.

An integrated model framework for low-carbon urban development

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The flows of carbon and energy produced by urbanized areas represent one of the aspects of urban sustainability that can have an important impact on climate change. For this reason, in recent years the quantitative estimation of the urban metabolism components has increasingly attracted the attention of researchers from different fields. On the other hand, it has been well recognized that the structure and design of future urban development can significantly affect the flows of material and energy exchanged by an urban area with its surroundings. In particular, several advanced models, operating at different spatial and temporal scales, have been developed and used for this purpose. On the other hand, it has been recognised the need to develop suitable tools and quantitative indicators in order to effectively support urban planning and management with the goal of achieving a more sustainable metabolism in future cities. In this context, an integrated modelling system to link urban planning decisions to the indicators of sustainable urban metabolism estimates is presented here. The software framework is able to estimate the carbon exchanges accounting for alternative scenarios which can influence urban development. The modelling system is based on four main components: (i) a Cellular Automata (CA) model for the simulation of the urban land-use dynamics (White et al., 1997; White and Engelen 2000; Blecic et al., 2009); (ii) a transportation model, able to estimate the variation of the transportation network load (Tsekeris and Stathopoulos 2003; 2006) and (iii) the ACASA (Advanced Canopy-Atmosphere-Soil Algorithm) model (Pyles et al. 2000; 2003) which was tightly coupled with the (iv) mesoscale weather model WRF (Skamarock et al., 2008) for the estimation of the relevant urban metabolism components.

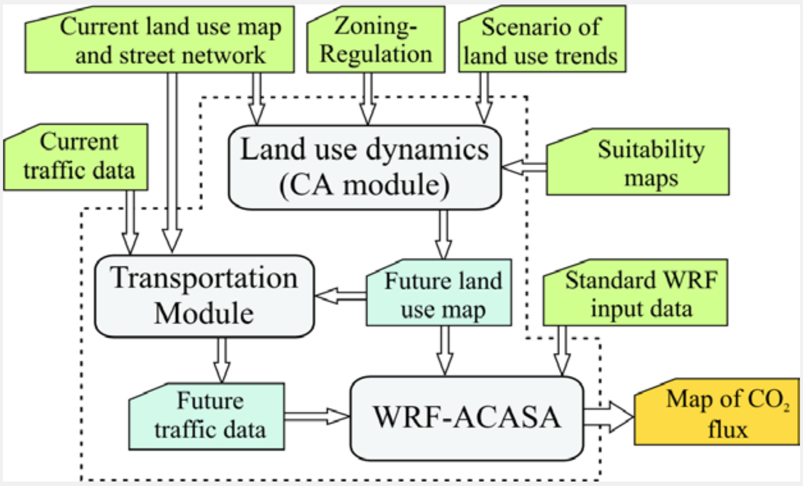

Figure 1. Outline of the modelling framework highlighting the most relevant data exchange between the involved components.

As shown in Figure 1, the land-use dynamics simulation module takes as main input the current map of land uses, the street network, the constraints related to the zoning regulation, the suitability of the cells to support the modelled land uses and the hypothesis on the future land-use trends. The latter may come from a demographic study and/or from assumption on the development of specific economic sectors. The results produced by the land-use dynamics module consist of a map of future land uses, which represent a spatial distribution of the aggregate land-use demand consistent with the main rules governing the functioning of an urban system. By varying the inputs into the CA model (e.g. zoning status, transport networks, presence of facilities and services), the model can be used to explore the future urban development of the area of interest under alternative spatial planning and policy scenarios. Such future land use map, together with the street network including the current traffic data, are used by the transportation module for estimating future traffic data coherent with the assumed land uses trends. As the final step of the modelling workflow, the future scenario of land use and traffic data, together with other relevant input data, are used by the coupled model WRF-ACASA for estimating future maps of CO_2 fluxes in the urban area under consideration. In particular, the ACASA model was adopted as an alternative to the existing suite of surface-layer schemes available in WRF due to the need to establish more flexible and realistic representations of surface-layer physics and physiology (Falk et al., 2010). The WRF model, driven by North American Regional Reanalysis data (NCAR-NCEP), is run down to its planetary boundary layer, where ACASA is called (Figure 2). The main features of each model involved in the modelling system outlined in Fig. 1 have been described in more detail in the previous newsletter and in the BRIDGE deliverables 4.1 and 6.1.

In addition to meteorological parameters, surface morphological parameters (population density, vehicle flux density, etc.) that drive the physiological responses also have to be specified, which vary by WRF land use type (including CA and/or satellite-derived data wherever possible). Morphological parameters not represented in the WRF land-use parameter suite, quantities such as mean leaf diameter and basal respiration rates for plant tissues, are specified with constant near-cardinal values for all land points. Marras et al. (2011) and Staudt et al. (2010) provide additional background information on morphological parameters and model sensitivities to each.

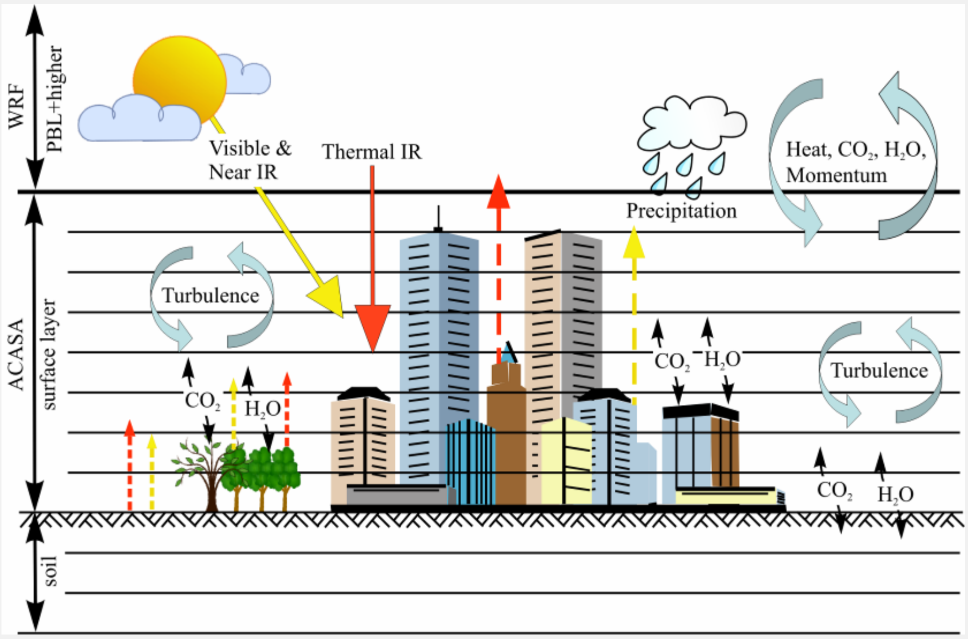

Figure 2. Scheme of the processes modelled by the coupled model WRF-ACASA.

In order to simulate energy and carbon fluxes in urban environment, the coupled WRF-ACASA model needs information about the land use and traffic scenarios produced respectively by the CA and transportation simulation modules. For this purpose, the CA module is able to export the future land use projections into the binary format accepted by the WPS. After the model design and set-up phase, an exploratory application on the city of Florence is now in progress in order to test the limits and potential of the framework. The 100m resolution CORINE land cover (CLC) was used as the input land-use layer. In order to effectively incorporate the zoning regulation data into the CA module, a semiautomatic pre-processing of the Florence urban masterplan ("Piano Regolatore Generale", PRG) was carried out. This zoning data layer was subsequently imported into the CA model, assigning to each zone type a "permissibility factor" of new urban development for each land-use type. Then, using the land cover and the planning regulation map as further input information for the CA model, several future land-use scenarios were generated. For example, the future land use projection represented in Figure 3 corresponds to a 20-year evolution of the urban area.

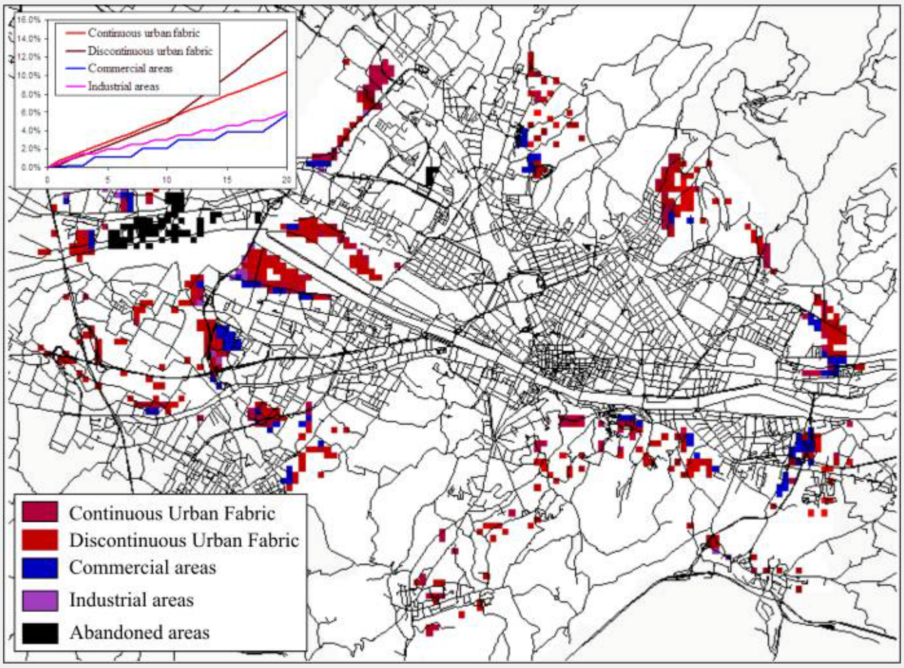

Figure 3. Future land use projection obtained by the CA module in 20 step of simulation. Only the cells where the land use was changed by the simulation are depicted. The embedded graph shows the extensions evolution of the actively modelled land uses.

Based on such future land-use scenarios, and after a preliminary phase of calibration based on the available traffic data, the transportation model is able to estimate the expected variation of the load of vehicles on the road network. Finally, the WRF-ACASA model is able to include the land-use maps and the traffic load information in its simulations to generate maps of CO_2 and other meteorologically significant fluxes. An example of such a set of monthly maps, obtained for the current land use and traffic data, using the meteorology of the year 2008 is shown in Figure 4.

The first set of WRF-ACASA simulations for the Florence domain for the control as well as for three planning scenarios have run to completion successfully, and the relevant model output has yet to be fully analyzed and compared with the corresponding control and observed sets.

The proposed methodology represents an effective integration between different models, with the purpose of linking urban planning decisions to the estimates of CO_2 fluxes in urban environment. The proposed framework allows, for example, to obtain realistic estimates on the impact of future planning decisions on CO_2 emissions in terms of its potential reduction from mitigation strategies.

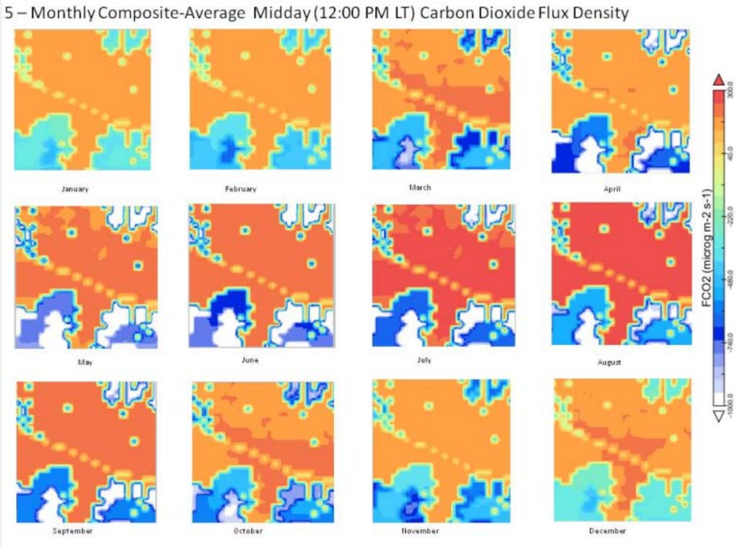

Figure 4. Monthly-averaged values of midday (12:00 PM, Local time) carbon dioxide flux density obtained through WRF-ACASA for all of 2008 using the current land uses and traffic data.

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WP7 Foresight exercise

The WP7 work team

On the 8th of December, the WP7 team organized a foresight exercise in London with the presence of experts from the case study cities and some international and BRIDGE experts on several dimensions of urban sustainability. In this article the goals defined for this event and the main steps undertaken to achieve them and also the main results and conclusions will presented.

Goals

The most important goals were the simulation of the DSS for the BRIDGE case studies (A) and understanding how decision-makers priorities, and the respective indicators' weights, change in response to different future scenarios (B). This event also aimed at increasing the knowledge on the socio economic characteristics of the case studies and to create another chance for local and international experts to interact with the BRIDGE team, regarding the DSS preliminary results.

(A) The DSS evaluation process requires indicators' scores (calculated with objective data, given by BRIDGE models or by the end-users) and weights (subjective appreciation by end-users of the relative importance of relevant parameters).

Scores were estimated by BRIDGE members (in what concerns the data to be calculated by models later on) and by end-users, to each planning alternative. To diminish the complexity of the process, indicators were chosen in advance (with the help of local experts). Participants were asked to take the role of urban planners, defining weights for one case study city, conditional to future scenarios.

A simplified version of the DSS was developed, considering a limited number of indicators. This allowed simulating the DSS and obtaining results for some case studies, considering the planning alternatives under evaluation.

(B) To understand how experts' priorities changed with the scenarios, and how these changes affected the DSS simulated results, 3 extreme scenarios were developed, based on the variation on urban drivers considered to the be essential for any study on sustainability.

The scenarios were the exercise's framework and introduced the variability needed to test the DSS sensitivity to changes. A Delphi survey was used to translate the experts' opinion on the relative importance of each indicator, into numbers in all scenarios (weights).

	Climate Change	Energy / Technological Development	Economy
BRIDGE in wonderland	+	+	+
Climate change is a burning issue	-	+	+
Lack of energy in freezing the economy	+	-	-

The scenarios were discussed according to 3 urban sustainability components: physical (urban design), economic (urban attractiveness) and environmental (energy). After a debate on urban sustainability (BRIDGE ultimate goal), a case study debate was held on the priorities in political decision, during which the questionnaire was answered for the 1st time. After the results presentation, participants had the opportunity to change their answers.

Scenario Analysis

When a municipality is defining their planning alternatives, this kind of exercise is very useful to promote a reflection on the aspects that will be determinant, not only in the present, but also in the future, and to try understanding how today choices' will affect the goals of the future.

It was emphasized during the scenario analysis that for energy or climate change constraints, all investments will have to be readjusted. In the absence of environmental, energy and economic constraints, the focus of urban policy would be the prevention of all other types of problems, and the increase of quality of life, in general. For more details on the conclusions please see Deliverable 7.1.

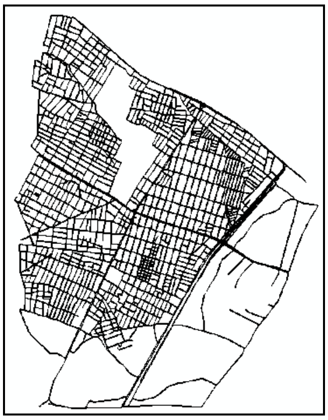
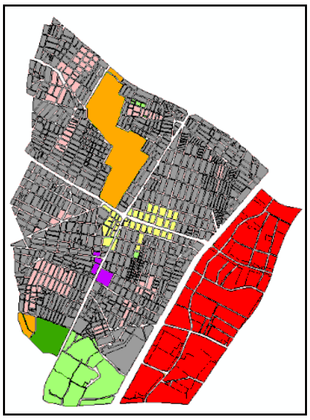
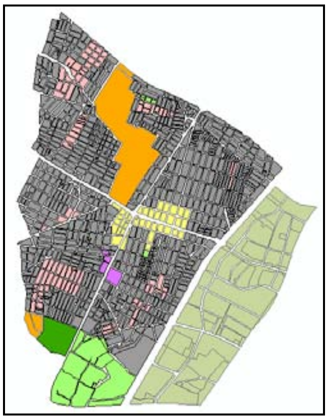
Delphi Questionnaire

BRIDGE evaluation formula is based on scores and weights: scores reflect the relative performance of the planning alternative when compared to a reference situation; weights define the relative importance ascribed by the end-users to each indicator. The final output measures the relative advantage of implementing a planning alternative when compared with the reference situation (in most case studies, the first alternative was chosen as reference). Results are presented only for Athens, Helsinki and Gliwice. In the London case, the planning alternatives were changed during the debate, making the previously prepared scores inappropriate for the corresponding evaluation.

Athens

In the Athens case study, the 3 planning alternatives being considered are related to the Egaleo municipality. The main goal is to *increase thermal comfort*, and the complementary goals are *: i)* to reduce heat island effect, ii) to decrease air pollution, iii) to increase energy efficiency, iv) to enhanced quality of life, and v) to improve human health.

Table 1. DSS results, for the 3 scenarios, concerning the Athens case study (1st and 2nd round)

	DN*	PA I		PA II		PA III	
round		1st	2nd	1st	2nd	1st	2nd
S I	1,00	1,17	1,20	1,08	1,13	**1,18**	**1,21**
S II	1,00	1,16	**1,17**	1,12	1,13	**1,17**	**1,17**
S III	1,00	**1,12**	**1,16**	1,04	1,09	1,10	1,14
							
		Apply cool materials on all buildings at Egaleo municipality and on roads		Change the land use of Eleonas from brownfield to built area		Change the land use of Eleonas from brownfield to green space	

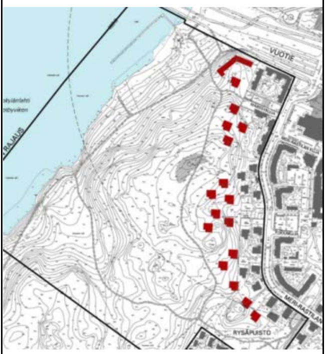
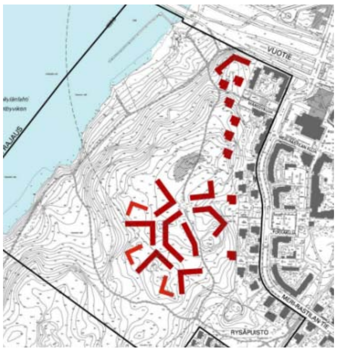
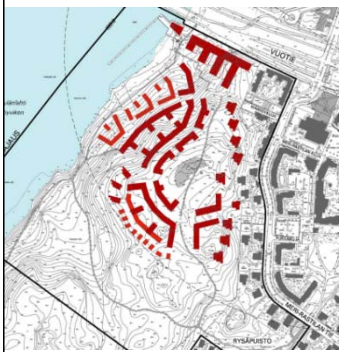
*Do nothing scenario

The 1st conclusion is that, for all scenarios, any alternative is considered better than doing nothing (all final results are higher than 1). The values given to PA I and III are quite similar. PAIII, related to aesthetics and post-materialist drivers, is preferred in the optimistic scenario, while alternative I becomes more important when climate change or lack of energy become key issues. In any case, the small difference between alternatives I and III mean that a more precise and detailed analysis is required. The reasons why participants were invited to change their answers was to find out if the debate with other participants and the presentation of results had any impact on their own opinions. In the Athens case, Table 1 shows that the changes were small.

Helsinki

The Finish case study focuses on 3 alternative residential areas, in a green area of the city of Helsinki, in the Meri-Rastila suburb. The main goal is to *increase of urban density within the walking distance of Rastila metro station (600 m radius) by creating new housing and workplaces, balancing the provision of green and built areas*. Complementary goals are: *i)* to minimize traffic based energy consumption and carbon dioxide emissions; ii) to develop a more balanced community and dwelling stock by building more owned dwellings and bigger apartments; iii) to maintain or increase services in Meri-Rastila; and iv) to maintain sufficient amount of green area and possibilities for outdoor recreation.

Table 2. DSS results, for the 3 scenarios, concerning the Helsinki case study (1st and 2nd round)

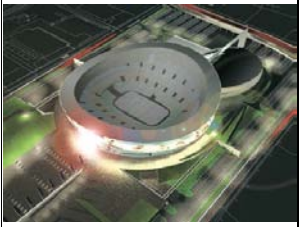
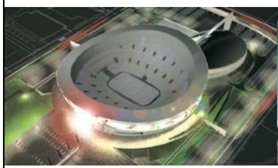
	PA I		**PA II**		**PA III**	
round	1st	2nd	1st	2nd	1st	2nd
S I	**1,00**	**1,00**	**1,00**	0,99	0,99	0,98
S II	1,00	1,00	1,08	1,10	**1,10**	**1,12**
S III	1,00	1,00	1,14	1,14	**1,16**	**1,15**
						
	Buildings for 500 inhabitants		Buildings for 1500 inhabitants		Buildings for 1800 inhabitants and 1000 new jobs	

The planning alternatives for Meri-Rastila presented similar performances in the 3 scenarios. When there are no economic or environmental constraints scenarios, the results for the 3 are almost equal: there are no clear gains of increasing the constructed area. In the 2nd and 3rd scenarios, the results point to the project with more inhabitants and built up area (PAIII), but with a marginal advantage over PAII. The 2nd round of answers did not bring significant changes to the average results.

Gliwice

In Gliwice, the construction of a new road increased the accessibility of the Polytechnic district, as well as the attractiveness and sustainability of improving the infrastructures. Several projects are being considering. The ones considered in this exercise represent an intervention in an area now occupied by a small sports zone, old industrial premises and some green spaces. The main goal is to *take profit from a new motorway, through a rehabilitation project*. Complementary goals are i) creation of a innovative economic structure, ii) improvement of quality of life, iii) development of metropolitan functions, iv) reinforcement of the public space attractiveness , and v) empowerment of civil society (governance).

Table 3. DSS results, for the 3 scenarios, concerning the Gliwice case study (1st and 2nd round)

	PA I		PA II		PA III	
round	1st	2nd	1st	2nd	1st	2nd
S I	1,00	1,00	1,04	1,01	**1,29**	**1,33**
S II	1,00	1,00	1,03	1,02	**1,04**	**1,05**
S III	1,00	1,00	1,07	1,08	**1,38**	**1,37**
						
	Sports Centre		a Centre for New Technologies		Sports Centre & Centre for New Technologies	

The results show that the PAIII is the robust option: whatever the context where the political decision is taken, the best alternative is the construction of the sports and technological centres. Some care should be taken in the interpretation of the 2nd scenario results: experts hesitated between doing either the sports centre or the technological centre or both, because neither investment is related to the key interest driven by the scenario.

Conclusions

At the end of such a productive exercise, it was difficult to summarize its main findings, so they it will only be presented some considerations concerning the case study questionnaire and the methodology.

Case study

This event was important for its contribution to a better planning alternative definition in London, and Gliwice, and also to the collection of socio-economic indicators.

The analysis of questionnaires showed the potential of the DSS. Different scenarios lead to different outcomes, ensuring the DSS sensitivity to changes. For Gliwice, there is a robust alternative which is the best in all scenarios. Conversely, the preferred alternatives both in Athens and Helsinki depend on future scenarios.

In summary, three different cases can be found: i) robust alternatives, which present the best score in all situations; ii) unclear evaluation of alternatives, where the scores are very similar, indicating the need to use more and better information; and iii) unstable results according to the scenarios, which reflects the need to deepen knowledge about future evolution, before a decision is taken.

Methodology and data

Questionnaire results show that the discussion generated a consensus process concerning the relative importance of the dimensions, but not on the weights inside each dimension. This indicates that while broad dimensions are a much clearer basis for forging a collective opinion than detailed indicators which require a more sound technical background.

Concerning the sensitivity analysis, it was shown to be a good choice to regroup the indicators in more well-balanced dimensions, instead of having several environmental criteria, what would reduce the DSS capacity to respond to changes in socio-economic variables, and artificially increase the environmental component of the political decision.

The foresight exercise was a means to collect different sets of weights, and to test the sensitivity of the multi-criteria formula. It is also important to stress that this simulation helped BRIDGE team, and also CoP members, to get a more exact notion of the final outputs of the software being developed.

Work ahead

The data prepared and collected for this exercise continues to be useful for the development of BRIDGE DSS, namely the scenarios developed will be adapted by BRIDGE modelers and combined with scenarios provided by institutions, such as IPCC.

This exercise would not be possible without the collaboration BRIDGE case study elements as well as the contribution of ALTERRA, TCD and FORTH.

BRIDGE Sustainable urban planning conference, 26 October 2011, Brussels

What do we need to know to develop and design a sustainable urban plan? Knowledge on the biophysical aspects of a city is necessary to make urban planning more sustainable. Human decisions have significant impacts on air quality, temperature, water use and heat/energy exchange in a city. Planning decisions are often made in ignorance of these impacts. Objectives of the conference are:

- To bring together urban planners, municipal politicians, architects, property developers, urban professionals in water management, public works and environmental management, consultancy firms, EU policy makers and scientists;
- To increase participants understanding about the integrated character of urban metabolism and its role in urban planning;
- Hands on experience with tools supporting sustainable urban planning.

Tentative programme:

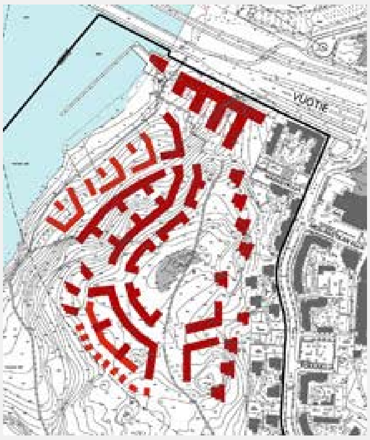
Morning

- Maria Yeroyanni (EU DG Environment officer): DG Environment view on sustainable cities.
- Arnaldo Cecchini (Università degli Studi di Sassari): Urgent problems in the urban environment: how to mitigate them with sustainable urban planning?
- Climate change and environmental expert (City of Stuttgart, Germany) (To be confirmed): Environmental aspects in spatial planning in Stuttgart.
- Winy Maas (Architect and Urbanist, MVRDV, Rotterdam, The Netherlands): The importance of using sustainability data in urban planning and design: Example of Dutch architecture.
- Nektarios Chrysoulakis(FORTH, project leader) BRIDGE project overview.

Afternoon

- Roland Vogt(University of Basel) Energy and CO2.
- Carlos Borrego(University of Aveiro) Air quality.
- Ab Veldhuizen (Wageningen University) Water management.
- Workshops: tools for sustainable urban planning.

For more information see BRIDGE website: http://www.bridge-fp7.eu/



Example of a plan to be assessed with the BRIDGE DSS: MeriRastila in Helsinki

BRIDGE Publications in peer – review journals

1. Järvi, L., Rannik, Ü., Mammarella, I., Sogachev, A., Aalto, P. P. , Keronen, P., Siivola, E., Kulmala, M., and Vesala, T., 2009. Annual particle flux observations over a heterogeneous urban area. Atmospheric Chemistry and Physics Discussions, 9, 13407 - 13437.

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3. Allen, L., Lindberg, F. and Grimmond, C.S.B., 2010. Global to City Scale Model for Anthropogenic Heat Flux. International Journal of Climatology, DOI: 10.1002/joc.2210.

4. Lindberg, F. and Grimmond, C.S.B., 2010. Continuous Sky View Factor from High Resolution Urban Digital Elevation Models. Climate Research, 42, 177 – 183.

5. Grimmond C.S.B., Blackett, M., Best, M., Barlow, J., Baik, J.J., Belcher, S., Bohnenstengel, S.I., Calmet, I., Chen, F., Dandou, A., Fortuniak, K., Gouvea, M.L., Hamdi, R., Hendry, M., Kawai, T., Kawamoto, Y., Kondo, H., Krayenhoff, E.S., Lee, S.H., Loridan, L., Martilli, A., Masson, V., Miao, S., Oleson, K., Pigeon, G., Porson, A., Ryu, Y.H., Salamanca, F., Shashua-Bar, L., Steeneveld, G.J., Tombrou, M., Voogt, J., Young, D. and Zhang, N., 2011. The International Urban Energy Balance Models Comparison Project: First results from Phase 1. Journal of Applied Meteorology and Climatology, 49, 1268 - 1292.

6. Loridan T, Grimmond, C.S.B., Offerle, B.D., Young, D. T., Smith, T., Jarvi, L. and Lindberg, F, 2011. Local-Scale Urban Meteorological Parameterization Scheme (LUMPS): longwave radiation parameterization & seasonality related developments. Journal of Applied Meteorology and Climatology, 50, 185 - 202.

7. Lindberg, F. and Grimmond, C.S.B., 2011. The influence of vegetation and building morphology on shadow patterns and mean radiant temperatures in urban areas: London case study. Theoretical and Applied Climatology (DOI 10.1007/s00704-010-0382-8).

8. Chrysoulakis, N., Abrams, M., Kamarianakis, Y., and Stanislawski, M., 2011. Validation of ASTER GDEM for the Area of Greece, Photogrammetric Engineering & Remote Sensing, 77, 157–165.

9. Grimmond C.S.B., Blackett, M., Best, M.J., Baik, J.J., Belcher, S.E., Beringer, J., Bohnenstengel, S.I., Calmet, I., Chen, F., Coutts, A., Dandou, A., Fortuniak, K., Gouvea, M.L., Hamdi, R., Hendry, M., Kanda, M., Kawai, T., Kawamoto, Y., Kondo, H., Krayenhoff, E.S., Lee, S.-H., Loridan, T., Martilli, A., Masson, V., Miao, S., Oleson, K., Ooka, R., Pigeon, G., Porson, A., Ryu, Y.-H., Salamanca, F., Steeneveld, G.-J., Tombrou, M., Voogt, J.A., Young, D. and Zhang, N., 2011. Initial Results from Phase 2 of the International Urban Energy Balance Comparison Project. International Journal of Climatology, 31, 244 – 272.

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11. Loridan, T., Grimmond, C.S.B., Offerle, B.D., Young, D.T., Smith, T., Järvi, l. and Lindberg, F., 2011. Local-Scale Urban Meteorological Parameterization Scheme (LUMPS): longwave radiation parameterization & seasonality related developments. Journal of Applied Meteorology & Climatology, 50, 185-202.

12. Mitraka, Z., Chrysoulakis, N., Kamarianakis, Y., Partsinevelos, P. and Tsouchlaraki, A., 2011. Improving the estimation of urban surface emissivity based on sub-pixel classification of high resolution satellite imagery. Remote Sensing of Environment: Special Issue on Remote Sensing of Urban Environments (in press).

13. Gobakis, K., Kolokotsa, D., Synnefa, A., Saliari, M., Giannopoulou, K. and Santamouris, M., 2011. Development of a model for urban heat islandprediction using neural network techniques. Sustainable Cities and Society Journal (in press).

14. Iamarino, M., Beevers, S., and Grimmond, C. S. B., 2011. High Resolution (Space, Time) Anthropogenic Heat Emissions: London 1970-2025. International Journal of Climatology (in press)

15. Järvi L., C.S.B. Grimmond, A.Christen Surface Urban Energy and Water Balance Scheme (SUEWS): Evaluation in Vancouver and Los Angeles. Journal of Hydrology (submitted)

16. A González, A Donnelly, M Jones, J Klostermann, A Groot and M Breil (In Press). Community of Practice Approach to Developing Urban Sustainability Indicators. Journal of Environmental Assessment Policy and Management.

Deliverables

1. Project Management Plan, D.1.1.
2. BRIDGE Web-Site, D.9.2 (operational).
3. Dissemination and Use Plan, D.9.1.
4. Inventory of current state of empirical and modelling knowledge of energy, water and carbon sinks, sources and fluxes, D.2.1.
5. Protocol to assess differences between knowledge supply and knowledge needs in the field, D.2.2.
6. Protocol to Develop Communities of Practice in the Context of the BRIDGE Project, D.2.3.
7. Datasets of air quality, energy, water, carbon and pollutants fluxes/concentrations, D.3.1.1.
8. GIS data and maps of energy and water fluxes, pollution concentrations, land cover and vegetation, D.3.2.1.
9. GIS data and maps on spatial, socio-economic development and impact indicators, D.3.3.1.
10. Model Selection Report, D.4.1.
11. DSS Design Report, D.6.1.
12. Socio-economic-environmental workshops Report, D.5.1.

Conferences Presentations

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3. González, A., Donnelly, A., and Jones, M., (2009). BRIDGE: SustainaBle uRban plannIng Decision support accountinG for urban mEtabolism. National FP7 Environmental Information Day, 9 October 2009, Dublin, Ireland.
4. Marras S., D. Spano, R.D. Pyles, M. Falk, C. Sirca, F. Miglietta, R.L.Snyder, K.T. Paw U., (2009). Energy and mass flux simulations in urban area using the ACASA model. American Geophysical Union Conference, San Francisco, December 2009.
5. San Jose R., J.L. Perez and R.M. Gonzalez, (2009). Urban efficient energy evaluation in high resolution urban areas by using adapted WRF-UCM and MICROSYS CFD models. Eos Trans. American Geophysical Union, 90 (52), Fall Meet.Suppl., Abstract B33D-0422.
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9. Amorim J.H; Lopes M.; Borrego C.; Tavares R. and Miranda A.I. (2010). Air quality modelling as a tool for sustainable urban traffic management. 18th International Conference on Modelling, Monitoring and Management of Air Pollution, Air Pollution XVIII, WIT press, pp. 3-14, 21 - 23 June, Kos, Greece.
10. Marras, D. Spano, R.D.Pyles, M. Falk, R.L.Snyder, K.T. Paw U., (2010). Application of the ACASA model in urban environments: two case studies. American Meteorology Society Ninth Symposium on the Urban Environment, 2-6 August 2010, Keystone, Colorado, USA.
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13. Loridan T, CSB Grimmond, BD Offerle, DT Young, TEL Smith & L Järvi, (2010). Recent developments & evaluation of the LUMPS-NARP urban land surface scheme. American Meteorology Society 9th Symp. Urban Environment, August 2–6, 2010 Keystone, Colorado, USA.

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16. Gobakis K., D. Kolokotsa, A. Synnefa, M. Saliari, K. Giannopoulou, M. Santamouris, (2010). Development of a model for urban heat island prediction using neural network techniques. SET2010 - 9th International Conference on Sustainable Energy Technologies, Shanghai, China, 24-27 August, 2010.

17. Synnefa A., Stathopoulou M., Sakka A., Katsiabani K., Santamouris M., Chrysoulakis N., Adaktylou N., and Cartalis C., (2010). Integrating sustainability aspects in urban planning: the case of Athens. 3rd International Conference PALENC 2010: Passive and Low Energy Cooling for the Built Environment. Jointly organized with 5th European Conference on Energy Performance and Indoor Climate in Buildings (EPIC 2010) & 1st Cool Roofs Conference. 29 September-1 October 2010, Rhodes island, Greece.

18. A. González, A Donnelly, M Jones and M Marques (2011). Impact Assessment Model for Sustainable Urban Planning. Proceedings of the 31st Annual Meeting of the International Association for Impact Assessment: Impact Assessment and Responsible Development for Infrastructure, Business and Industry; Puebla, Mexico (29May-4June, 2011).

19. González, A (in press). Developing and Applying a Decision Support System (DSS) for Assessing Planning Alternatives based on an Impact Assessment Model for Urban Metabolism. VI Congreso Nacional de Evaluación de Impacto Ambiental. 6-8 April 2011, Albacete, Spain.

Deliverables (...continued)

13. Mid-term Report, D.1.3.
14. Datasets of air quality, energy, water, carbon and pollutants fluxes/concentrations (1st update), D.3.1.2
15. GIS data and maps of energy and water fluxes, pollution concentrations, land cover and vegetation (1st update), D.3.2.2.
16. GIS data and maps on spatial, socio-economic development and impact indicators (1st update), D.3.3.2.
17. Report on the impacts assessment model for urban metabolism, D.5.2.
18. Indicators definition report, D.5.3.
19. BRIDGE Published Material, D.9.3.i (see Publications section).
20. First DSS Prototype, D.6.2.
21. Strategic scenario analysis, D.7.1.

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