Urban metabolism and resource optimisation in the urban fabric: The BRIDGE methodology

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Motivation: ENV.2007.2.1.5.1

- **Urban metabolism and resource optimization in the urban fabric:**
  - ✓ Devise innovative strategies to decouple the resource use from economic development.
  - ✓ Devise innovative strategies to optimize urban planning and design.
  - ✓ Identify all relevant physical flows through European urban systems.
  - ✓ Evaluate the associated environmental impacts.
  - ✓ Develop strategies and tools for sustainable use of energy and materials.
  - ✓ Involve urban planners, infrastructure developers and social networks.

The problem

- Urban development has to meet the main requirements for sustainability by **optimising** the use of space, energy and materials and by **decoupling** conventional resource use from economic development.
- The **planning policies** often reflect the logic of the market. They would better reflect a vision of urban development, in which **environmental and social considerations** are fully embedded in spatial planning policies.

The challenge

- **Urban metabolism:** Urban communities consume material and energy inputs, process them into usable forms, and eliminate the wastes from the process.
- Understanding the pattern of **energy and material flows** through a community's economy provides a systemic reading of the present situation, for objective setting and development of indicators for sustainability.
- **Settlement planning** is a key aspect of sustainability, which requires that a settlement be linked to an appropriate, local, ecological unit from which it would draw resources.
- **There is a need for an analytical approach** to provide information on which the decisions will be based.

The challenge

- The **optimisation** of the urban planning is needed in order to:
  - ✓ Accommodate increasing demand for space and resources.
  - ✓ Reduce material and energy consumption.
  - ✓ Include sustainability objectives at all scales.
  - ✓ **Incorporate bio-physical scientific knowledge into the planning process** on a routine basis.

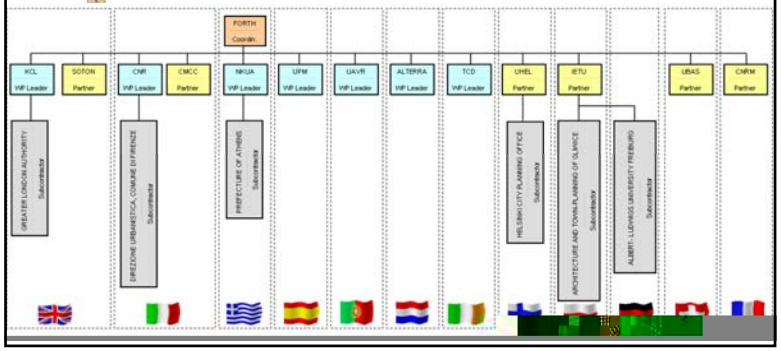
The BRIDGE idea

- To provide the means to:
  - ✓ quantitatively estimate the various components of the urban metabolism,
  - ✓ quantitative estimate their socio-economic and environmental impacts,
  - ✓ support resource optimisation in urban fabric.
- To provide a **DSS** that will incorporate sustainability aspects in spatial planning processes.

The BRIDGE objectives

- Bridge the gap between bio-physical sciences and urban planners.
- Illustrate the economic advantages of accounting for environmental issues in urban planning.
- Provide the means to quantitatively estimate the various components of the urban metabolism.
- Provide the means to quantitatively estimate the environmental impacts of the above components.
- Provide the means to translate the above impacts to socio-economic costs.
- Support the development of planning strategies to decouple resource use and economic development.
- Provide the means to optimise resources in urban planning.
- Involve local and regional stakeholders in validation of project's achievements.
- Support the implementation of EU policy on urban environment.

The BRIDGE Consortium



The BRIDGE approach

- Advances in **bio-physical sciences** will be exploited to develop a **DSS** which will be used to support the urban planning by proposing quantitative measures and **guidelines** for sustainable use of energy and materials.
- A **CoP** approach will be used, which means that local stakeholders and scientists will meet on a regular basis in order to learn from each other.
- The DSS will provide several urban planning **scenarios**, which will be evaluated by the end users. In this way sustainable planning strategies will be devised, based on quantitative assessments of urban metabolism components.

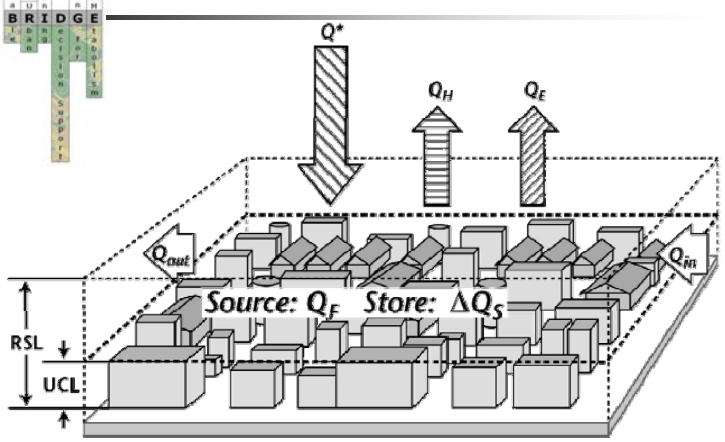
The BRIDGE approach

- **Urban metabolism** is considered as the exchange and transformation of energy and matter between a city and its environment.
- The city is considered as a **system** and the physical flows between this system and its environment will be quantitatively estimated in the framework of the project.
- BRIDGE will focus on the following components of urban metabolism:
  - ✓ **Energy**
  - ✓ **Water**
  - ✓ **Carbon and pollutants**

The BRIDGE approach

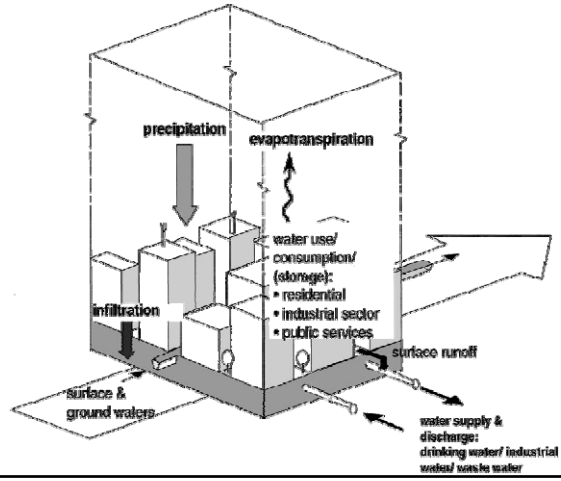
- The **fluxes** of energy, water carbon and pollutants will be measured and modelled in order to calculate the net-fluxes between the city and its environment.
- Energy and material flows will be simulated in a 3D context and also dynamically by using state-of-the-art **numerical models** which normally simulate the complexity of the urban dynamical process.
- **Remote sensing** and in-situ techniques will be used to provide as many observational data as possible.
- A proper combination of "on-line" and "off-line" models will produce the optimal results in terms of physical flows simulations in BRIDGE case studies.

The BRIDGE approach

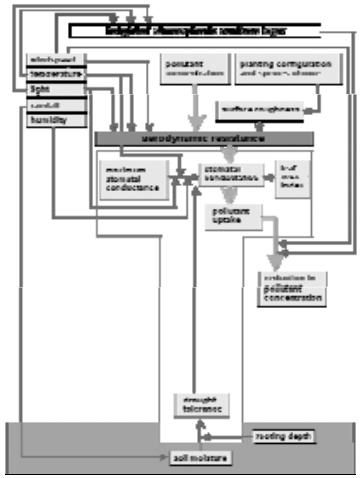


$Q^* + Q_F = Q_H + Q_E + \Delta Q_S + \Delta Q_A + S$ (W/m²)

The BRIDGE approach



The BRIDGE approach

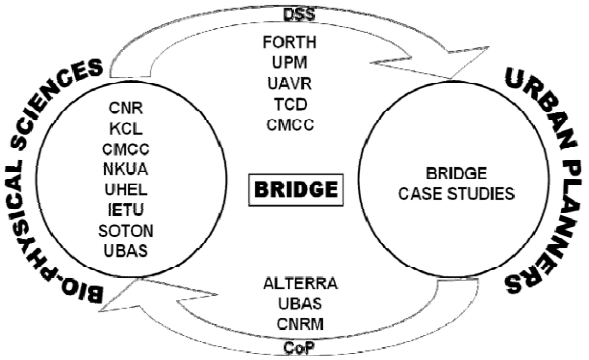


The BRIDGE approach

- Based on the quantitative estimations of physical flows, a set of environmental and socio-economic impacts will be defined using the **DPSIR** framework.
- In this way it will be possible to select the most relevant **impacts** to be monitored using relevant **indicators** and to be translated into **socio-economic costs**.
- Once the list of impact indicators has been defined, each **indicator's performance** will be assessed with respect to the objectives of sustainable urban planning.
- The DSS will **integrate** the data, the models and the impact assessment methodologies and to provide planning scenarios.

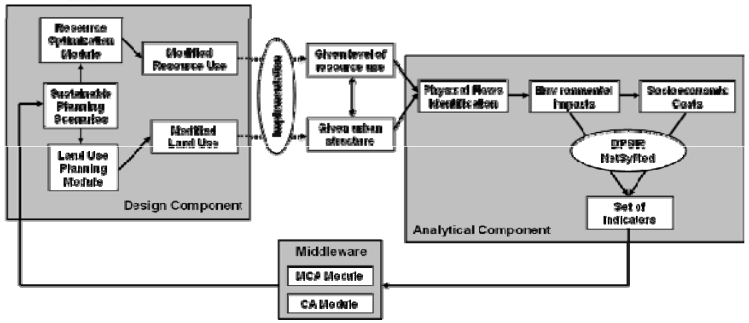
Implementation

Implementation



Implementation

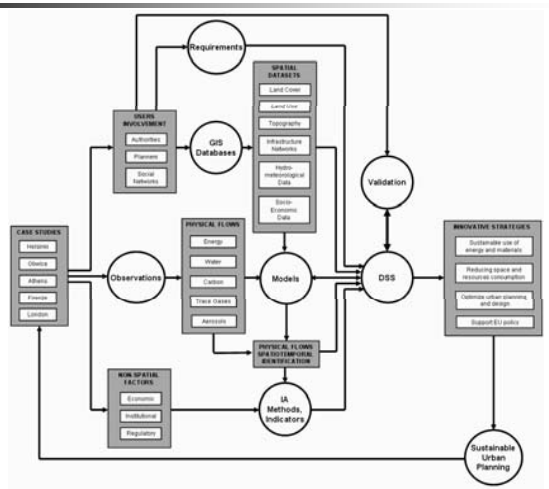
- The main components of the BRIDGE DSS.

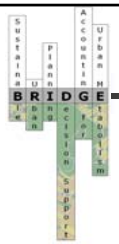


Implementation

- The evaluation of the DSS presupposes the definition of a set of **strategic scenarios** based on indicators for baseline and extreme situations.
- A number of key issues will be addressed in the definition of strategies for future urban development under environmental and political constraints such as:
  - ✓ Climate change impacts and adaptation.
  - ✓ Mobility.
  - ✓ Energy and renewable sources.
  - ✓ Land use change and territorial boundaries.
- The BRIDGE sustainable planning strategies will be based on these scenarios, which will illustrate the socio-economic benefits of the land use planning optimisation.

Implementation





Conclusions

- BRIDGE will **provide the means** to close the gap between bio-physical sciences and urban planners and to illustrate the advantages of accounting for urban metabolism issues in design decisions.
- The **innovation** of BRIDGE lies in the development of DSS which reflects the multi-dimensionality nature of the urban metabolism, based on indicators easily understood by a non-scientific public.
- The **advances** that the project will bring about is related to: instrumentation, databases, modelling, DSS and sustainable planning strategies.
- The overall **performance indicator** will be the extent to which urban planners are involved in, and then **make use** of BRIDGE outputs.