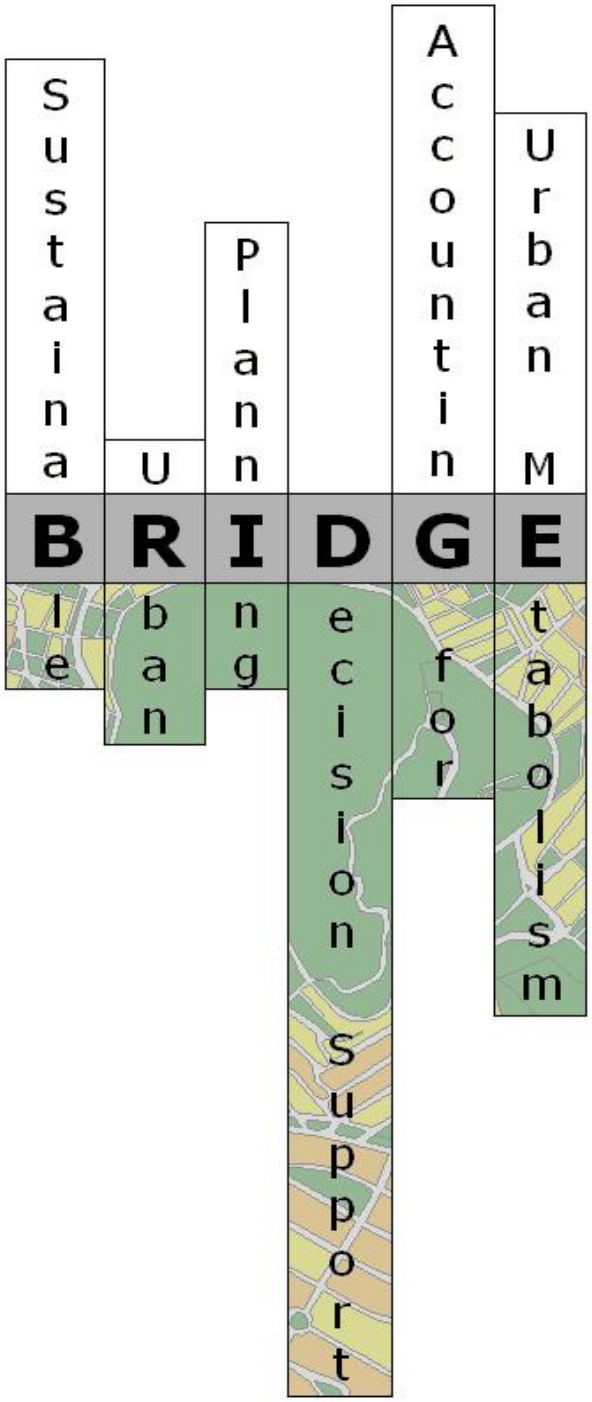


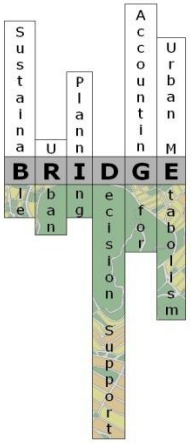
BRIDGE Demonstration Event

Brussels, November 26, 2011

BRIDGE Project Progress

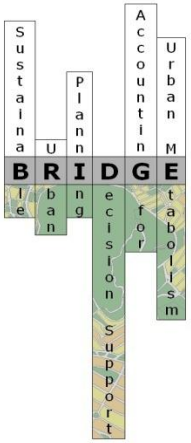
Nektarios Chrysoulakis
FORTH

Urban metabolism



- Urban metabolism considers a city as a **system** and distinguishes between energy and material flows.
- "Metabolic" studies are usually **top-down** approaches that assess the **inputs and outputs** of food, water, energy, etc. from a city, or that **compare** the metabolic process of several cities.
- BRIDGE: **Bottom-up** approach based on **quantitative** estimates of urban metabolism components at **local scale**, considering the urban metabolism as the **3D** exchange and transformation of energy and matter between a city and its environment.

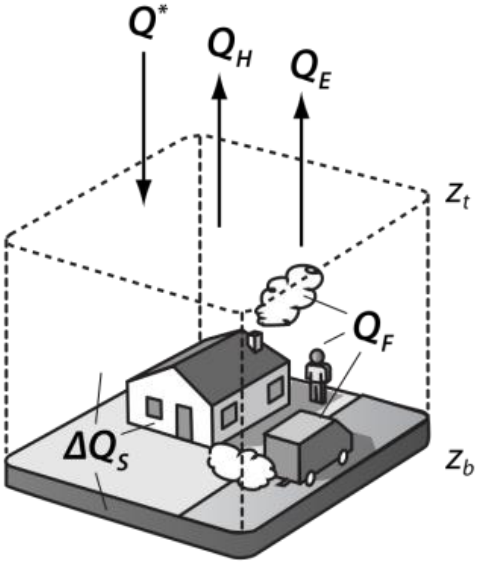
Why BRIDGE?



- Recent advances in bio-physical sciences have led to **new methods** to estimate energy, water, carbon and pollutants fluxes.
- There is **poor communication** of this new knowledge to end-users, such as planners, architects, engineers and policy makers.
- BRIDGE responds to this challenge by providing the means to **close the gap** between bio-physical sciences and urban planners, and to illustrate the advantages of **accounting** for urban metabolism in urban planning.

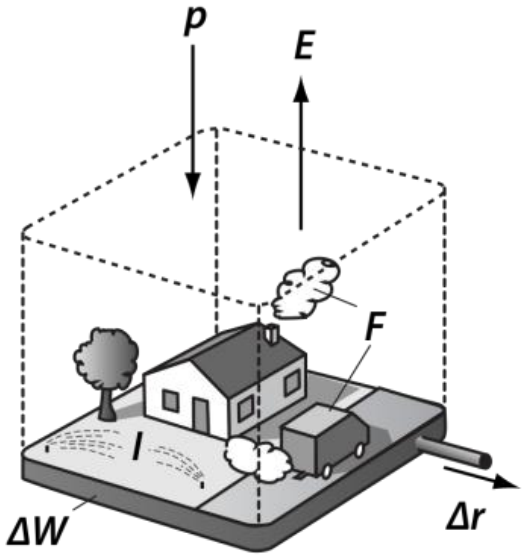
Energy, water and carbon fluxes

(a)



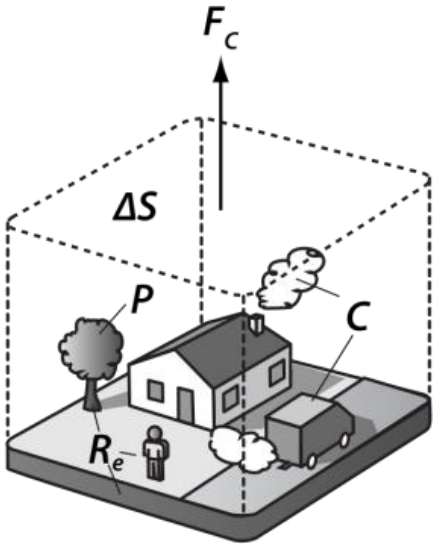
$$Q^* + Q_F = Q_H + Q_E + \Delta Q_S$$

(b)



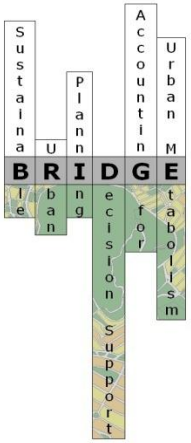
$$p + F + I = E + \Delta W + \Delta r$$

(c)



$$F_C + \Delta S = C + R_e - P$$

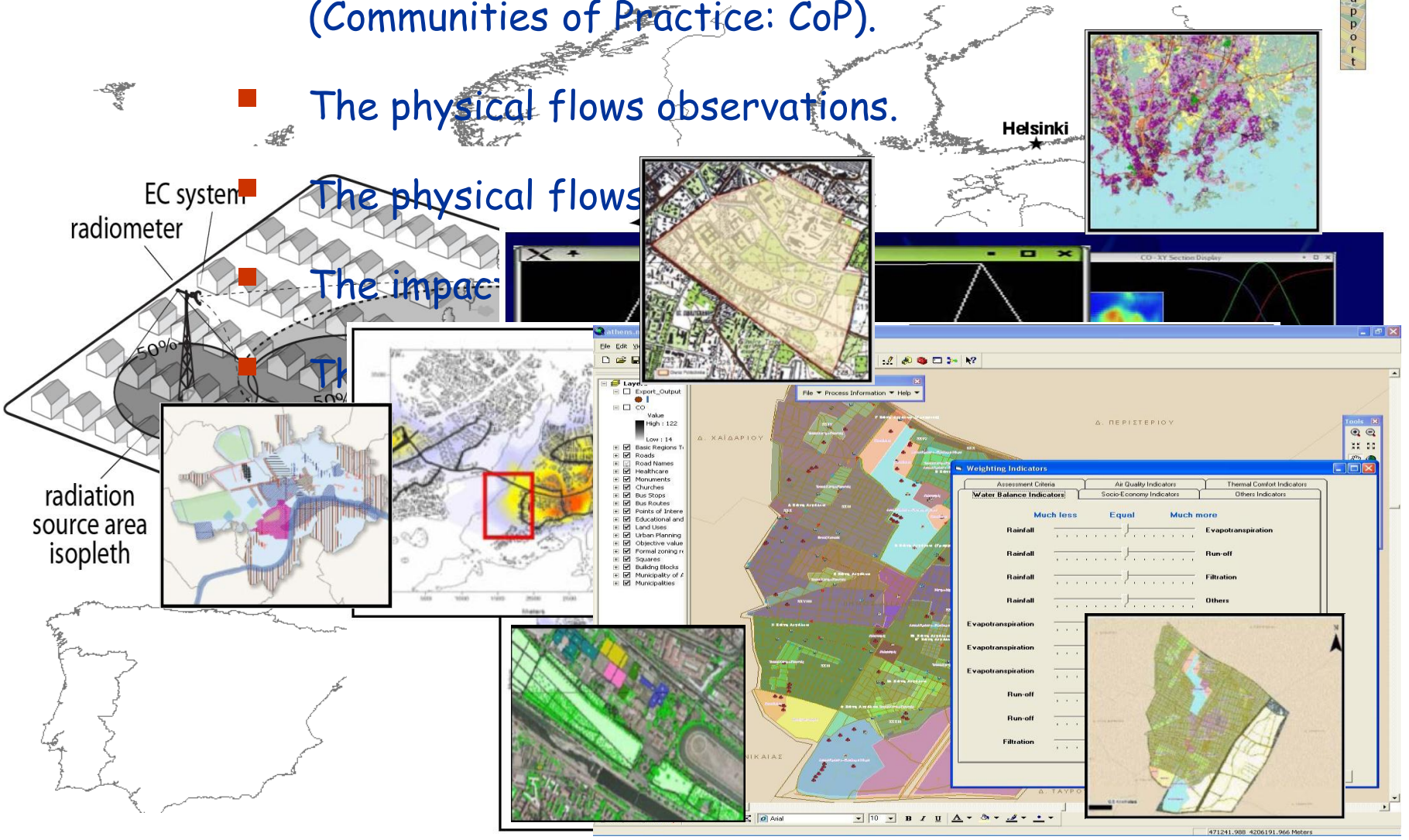
The BRIDGE idea



- To define urban metabolism by means of energy, water, carbon and air pollution fluxes in **local scale**.
- To examine how the **change of land use** and resources use affects the above fluxes.
- To develop **indicators** to quantify their **impacts**.
- To develop a **DSS** based on these indicators.
- To use this DSS to **evaluate urban planning alternatives** in several case studies.
- To support **sustainable planning strategies** based on these evaluations.

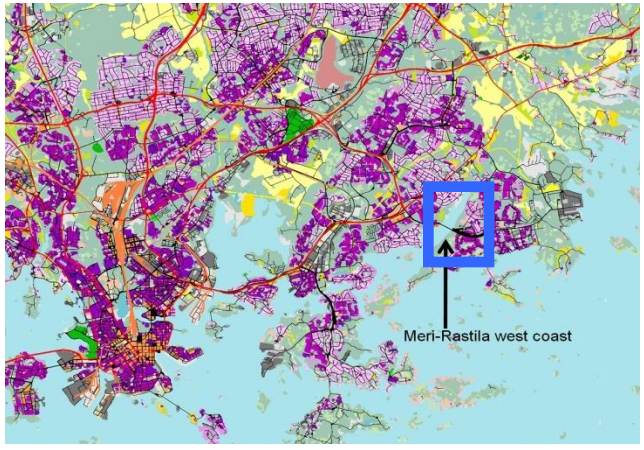
The main components

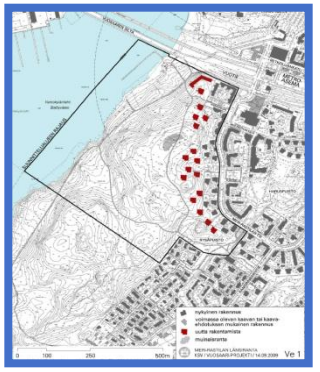
- The involvement of users (Communities of Practice: CoP).
- The physical flows observations.
- The physical flows
- The impac
- Th



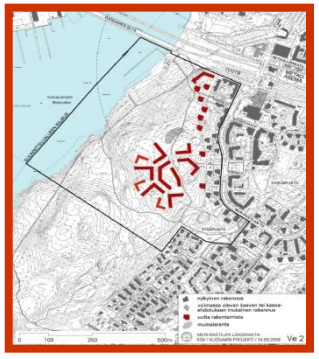
The planning alternatives

Helsinki:
Meri-Rastila

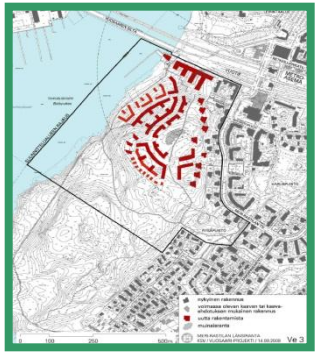




Alternative 1:
Supplementing the existing blocks

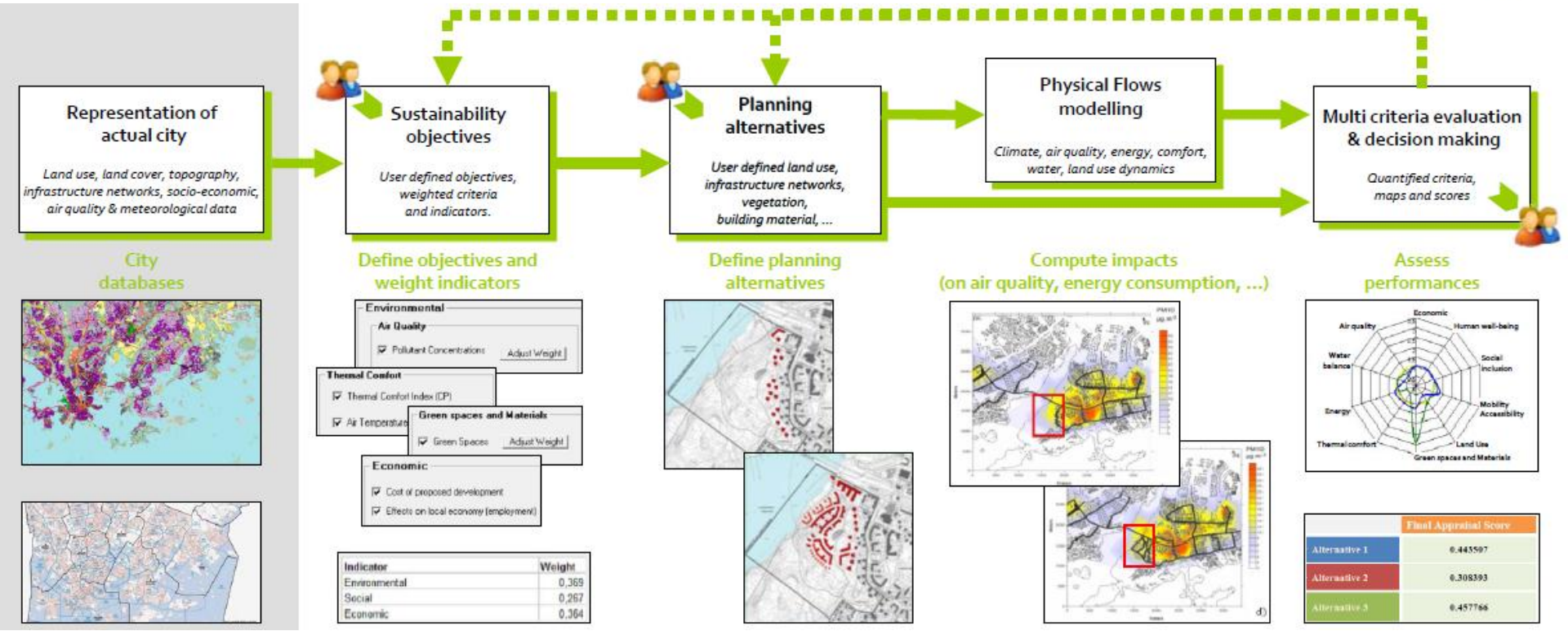


Alternative 2:
Rastilla Hill

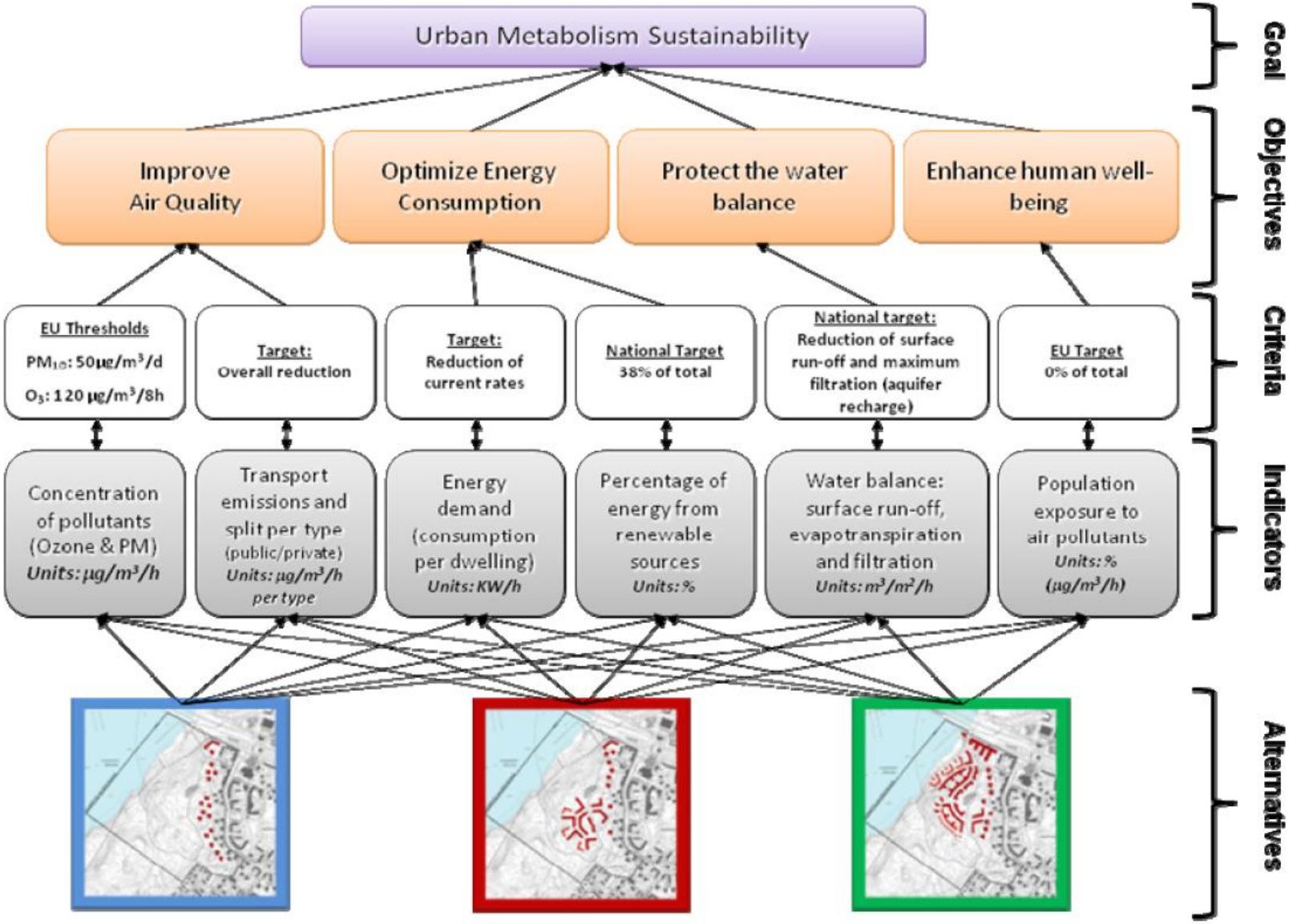


Alternative 3:
Coastal Rastilla

The Decision Making Methodology



The Decision Making Methodology



Data collection in Case Studies

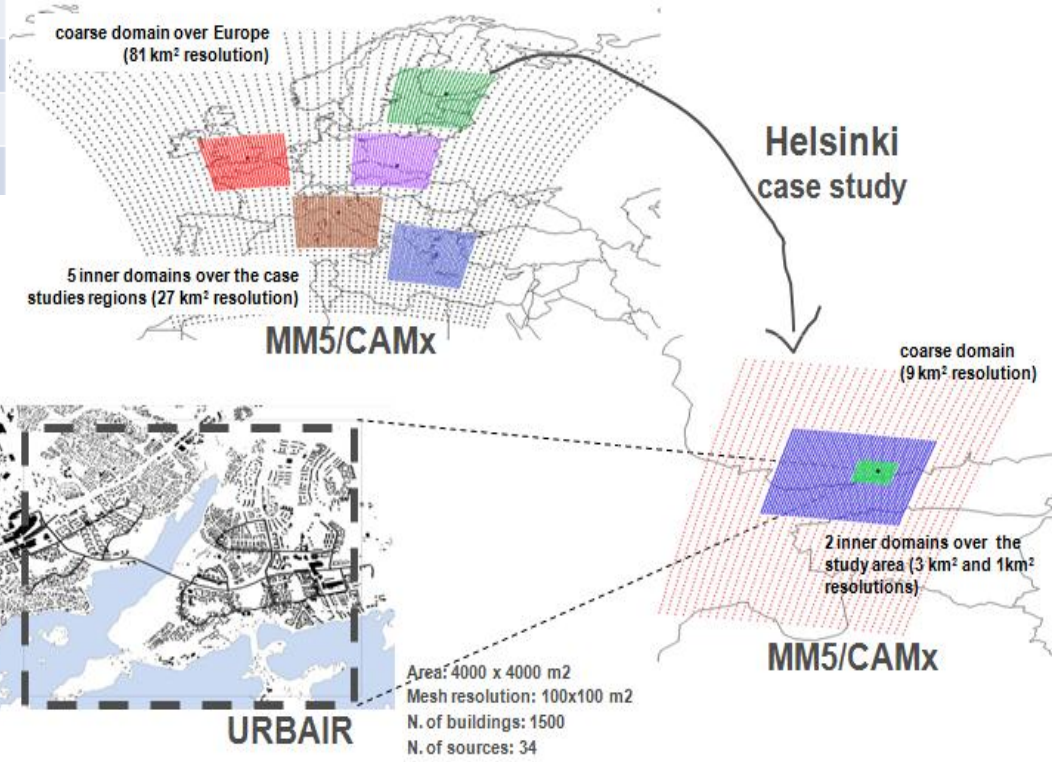
- **Firenze**
  Turbulent fluxes; air quality; dust concentration & fluxes; airborne campaign; bioaccumulation;
- **London**
  Turbulent fluxes; air quality; airborne campaigns; DEM & Sky view maps
- **Gliwice**
  Turbulent fluxes; air quality; socioeconomic issues
- **Athens**
  Air quality; thermal confort of buildings; socioeconomic issues; urbanin heat island; mobile outdoor monitoring; street microclimate; mapping NDVE, albedo LST, LSE
- **Helsinki**
  Turbulent fluxes; air quality; Urban tree phys ; street microclimate; Stormwater quantity and quality

Cross cutting

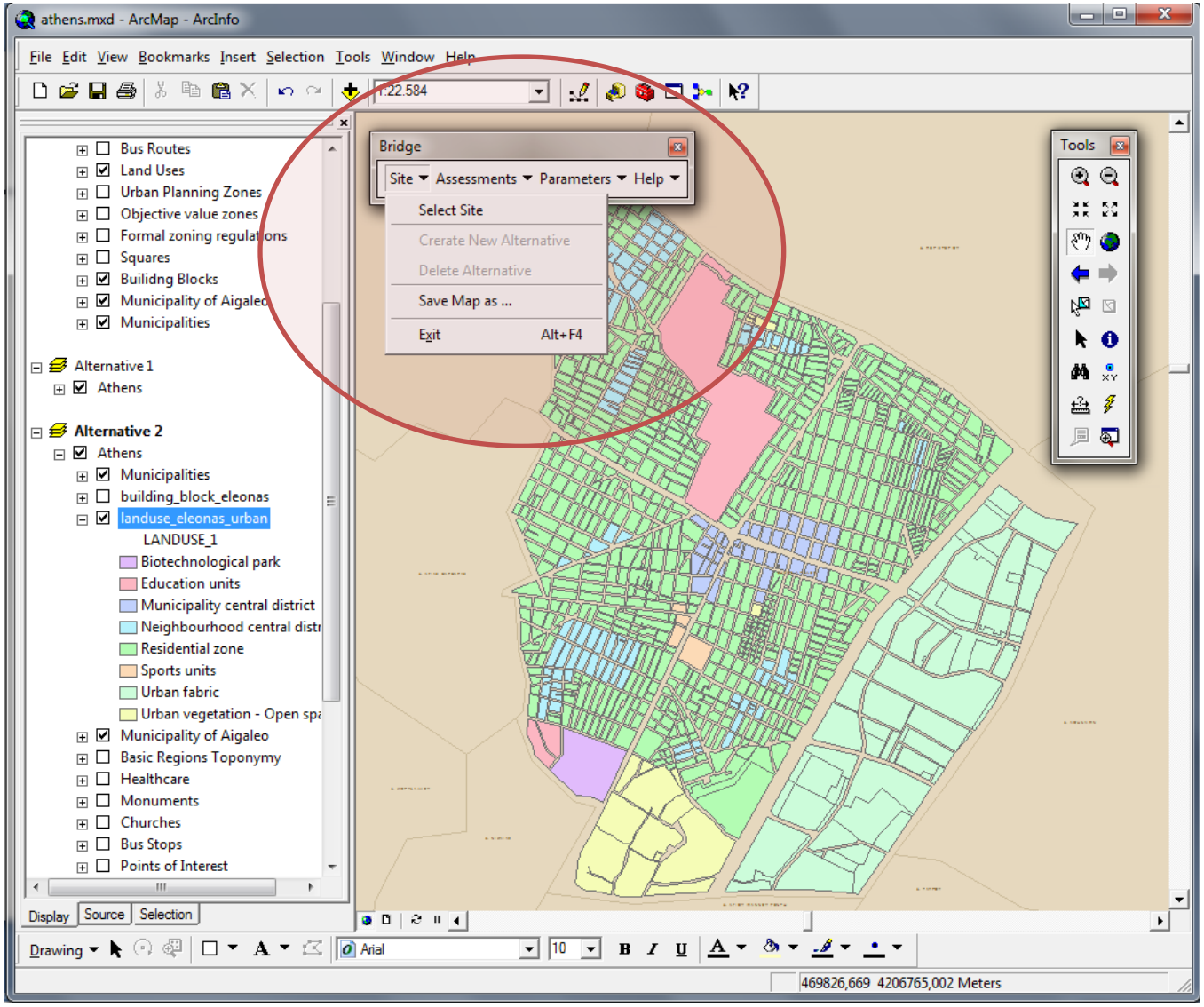
Time series of EO derived emissivity and albedo maps; DEMs.

Modelling Cascade

Scale		Offline	Online
Meso/Global	LUCY		Online
Meso- Local	WRF/CMAQ (UCM/NOAH)	Offline	
Meso- Local	WRF/ACASA	Offline	
Meso- Local	WRF/CHEM	Offline	
Meso-Local	MM5/CAMx	Offline	
City	URBAIR		Online
Local	SURFEX (TEB)		Online
Local	LUMPS		Online
Local	SIMGRO		Online

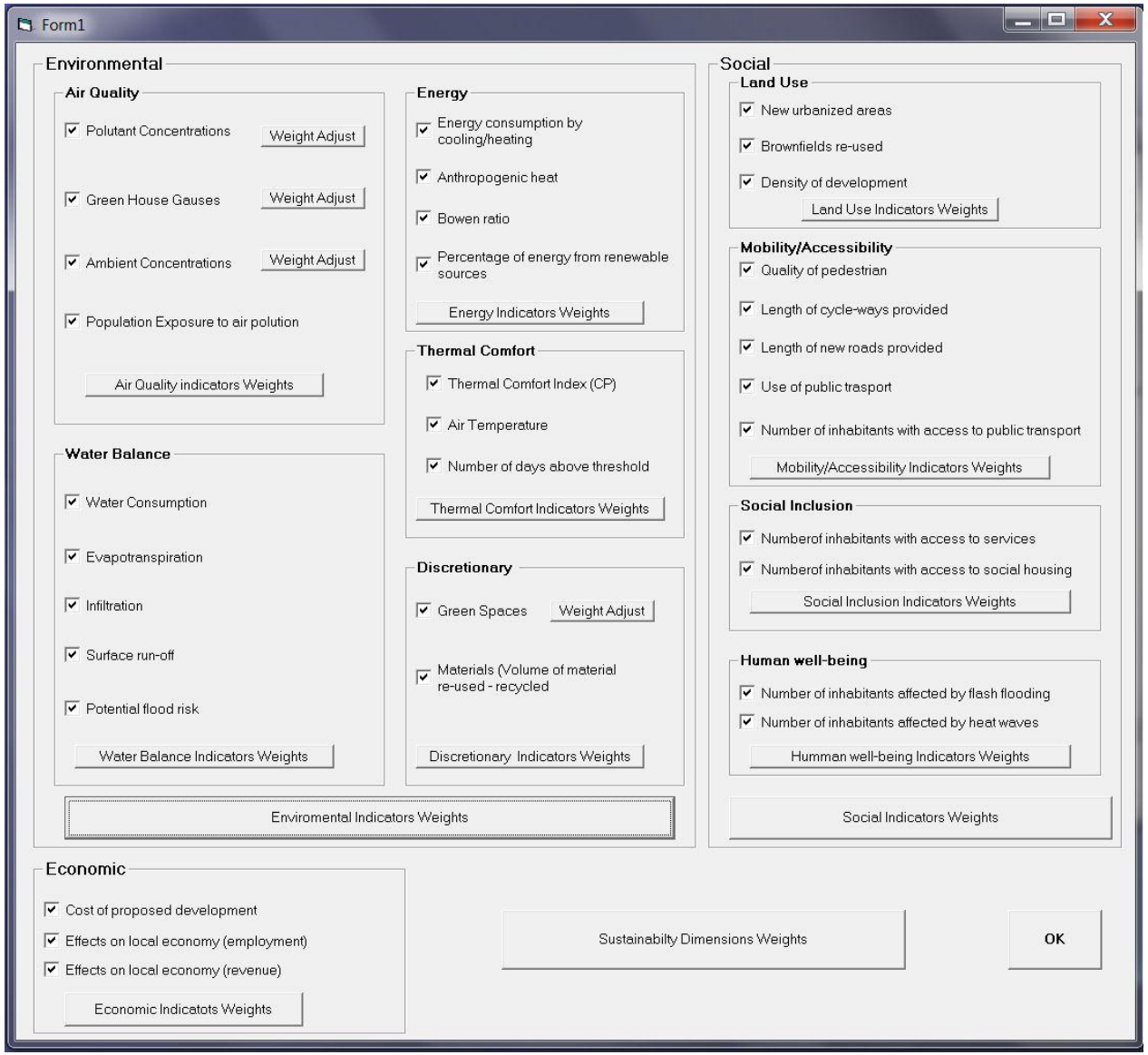


The BRIDGE DSS



…is developed as an add-on for ESRI ArcGIS to fully exploit geographical data capabilities

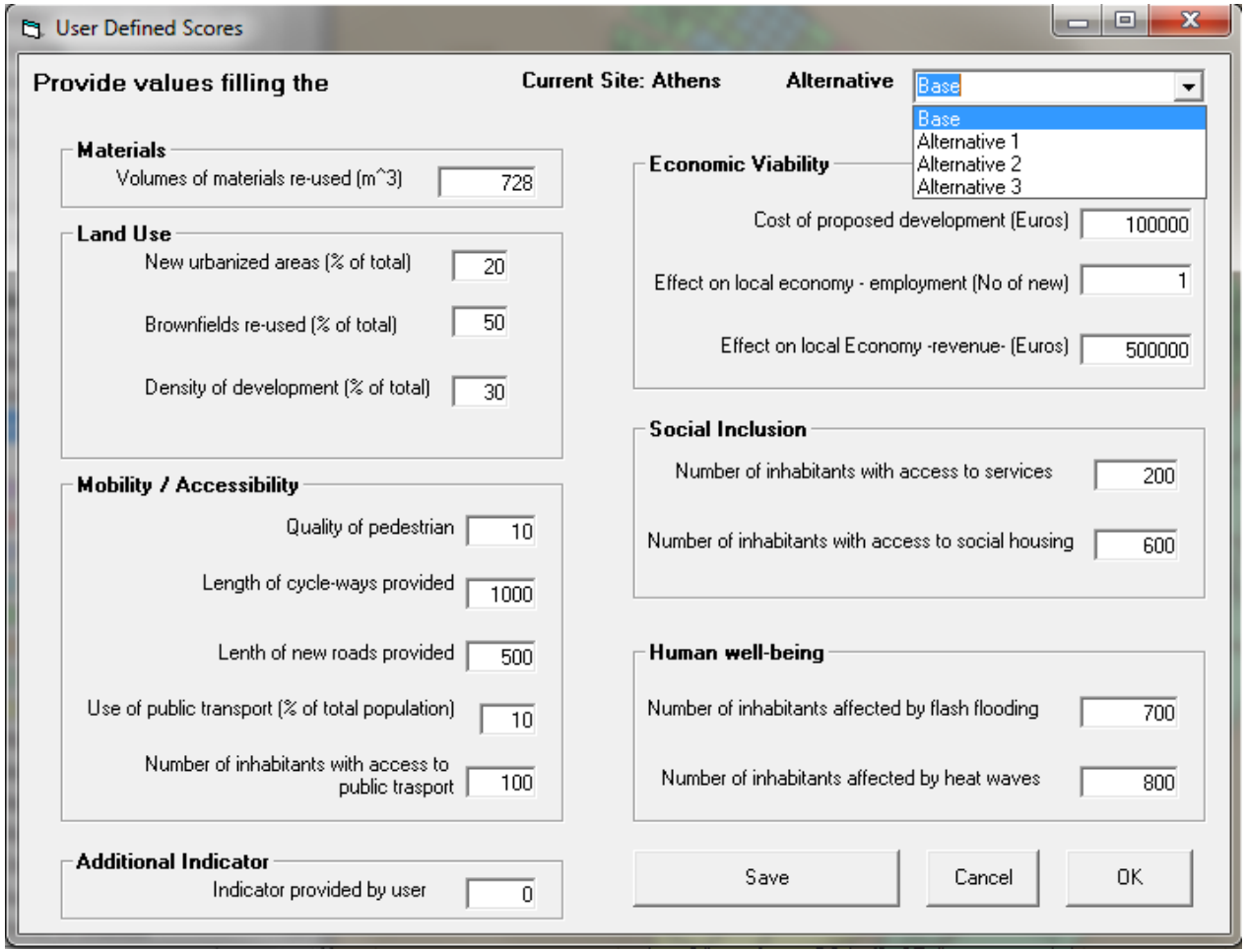
The BRIDGE DSS



Indicators are organized in a hierarchy to make it easier for the user to select and define their relative importance

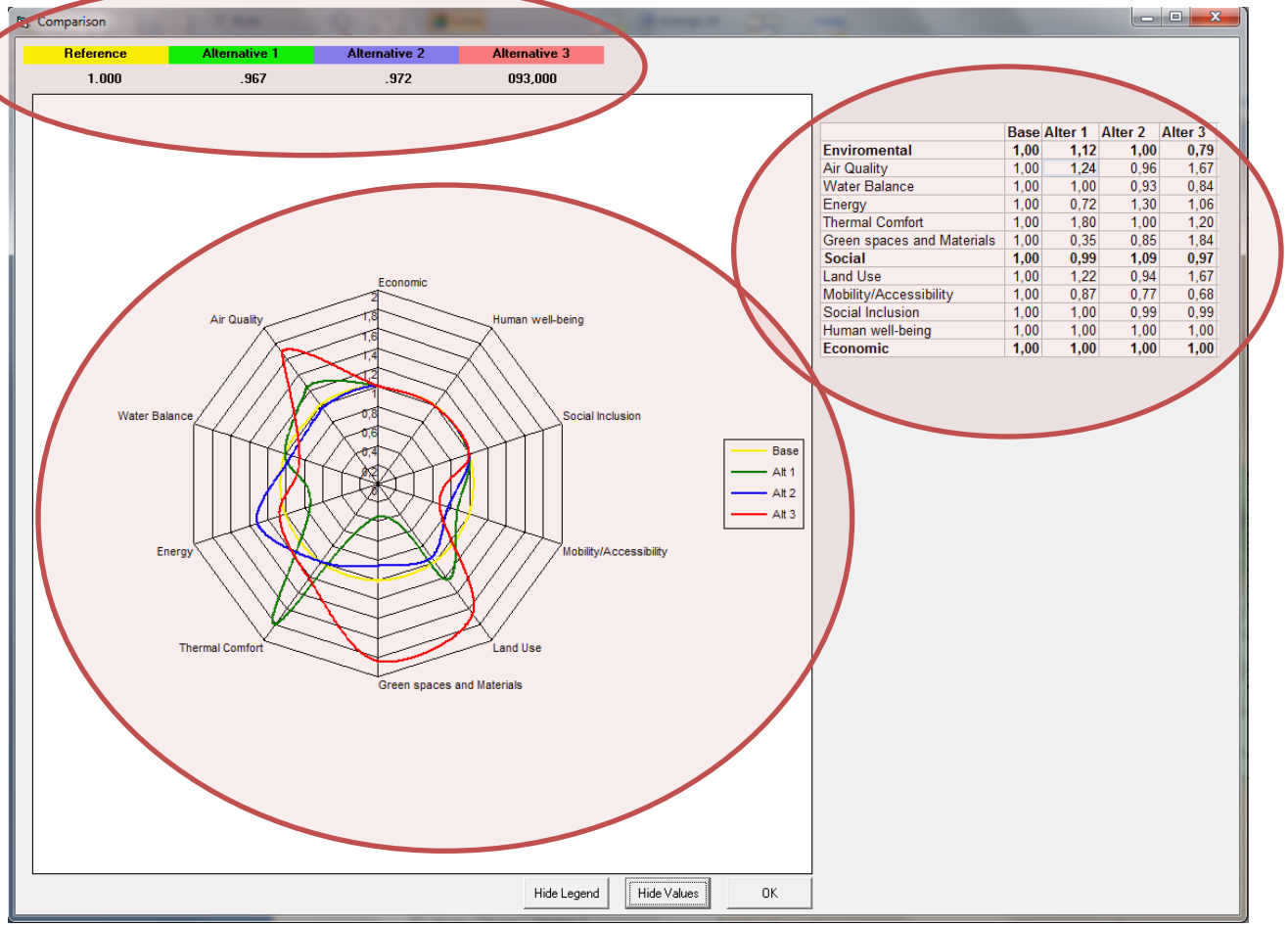
The BRIDGE DSS

Socio-economic indicators values are not defined by the environmental models. These values are assigned by the user for all alternatives.



The DSS Outputs – alternatives scores

Through the multi-criteria evaluation process…

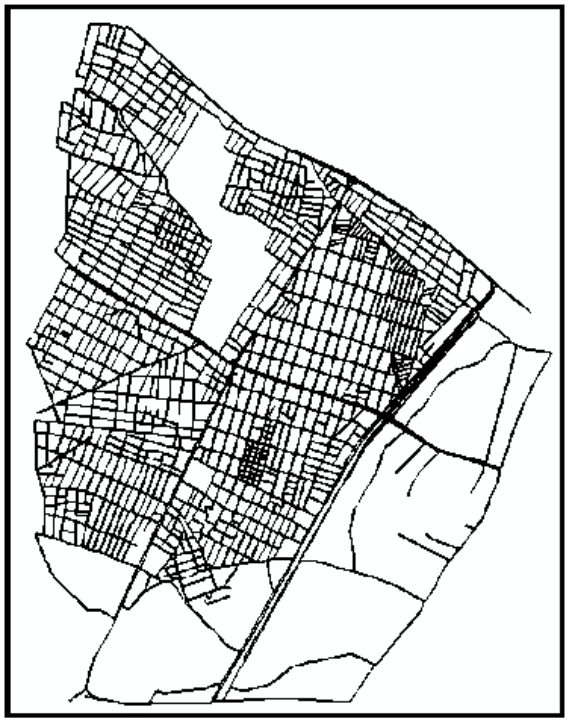


	Base	Alter 1	Alter 2	Alter 3
Enviromental	**1,00**	**1,12**	**1,00**	**0,79**
Air Quality	1,00	1,24	0,96	1,67
Water Balance	1,00	1,00	0,93	0,84
Energy	1,00	0,72	1,30	1,06
Thermal Comfort	1,00	1,80	1,00	1,20
Green spaces and Materials	1,00	0,35	0,85	1,84
Social	**1,00**	**0,99**	**1,09**	**0,97**
Land Use	1,00	1,22	0,94	1,67
Mobility/Accessibility	1,00	0,87	0,77	0,68
Social Inclusion	1,00	1,00	0,99	0,99
Human well-being	1,00	1,00	1,00	1,00
Economic	**1,00**	**1,00**	**1,00**	**1,00**

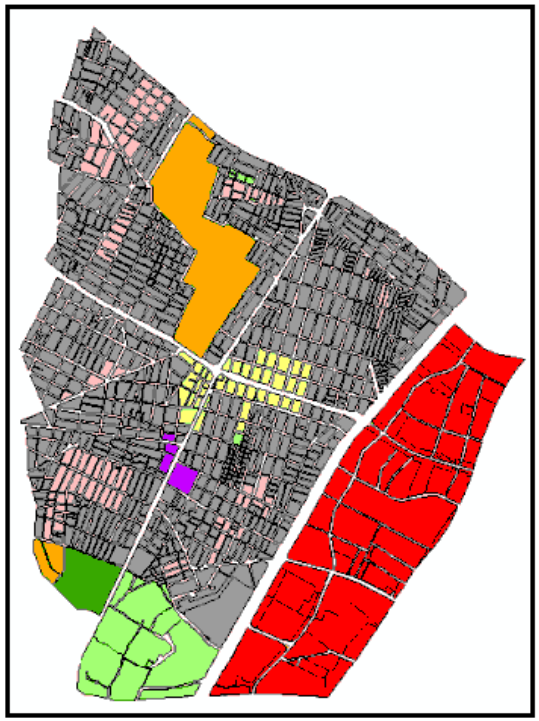
- a *final appraisal score* for each alternative is computed
- and the *sub-scores* computed are also presented as numbers
- and in the form of a *spider diagram*

The DSS Outputs – indicators maps

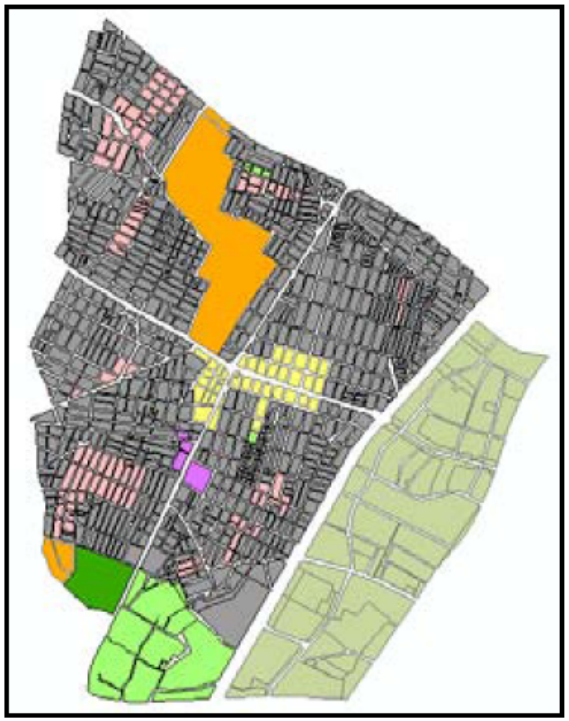
Athens Planning Alternatives:



Apply cool materials on all buildings at Egaleo municipality and on roads



Change the land use of Eleonas from brownfield to built area

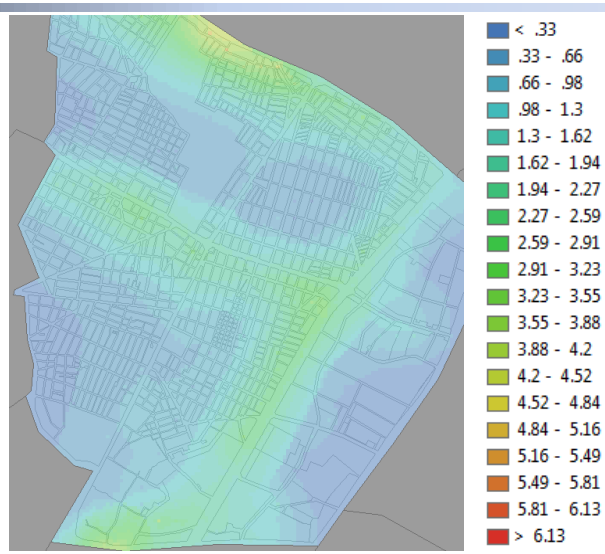


Change the land use of Eleonas from brownfield area to green space

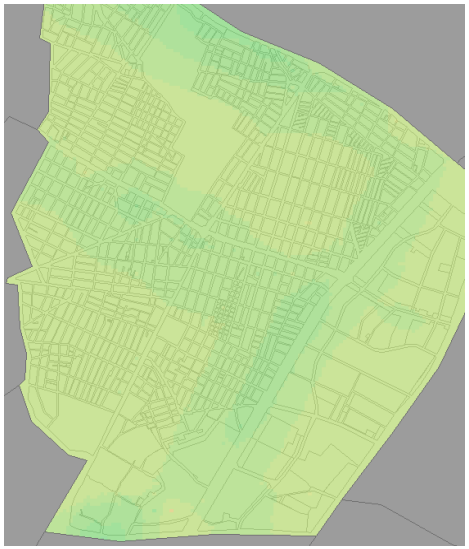
The DSS Outputs – Men NO_x Concentration

Athens.
Mean NO_x concentrations ($\mu g/m^3$)
07:00 - 10:00 LST
in **August**.

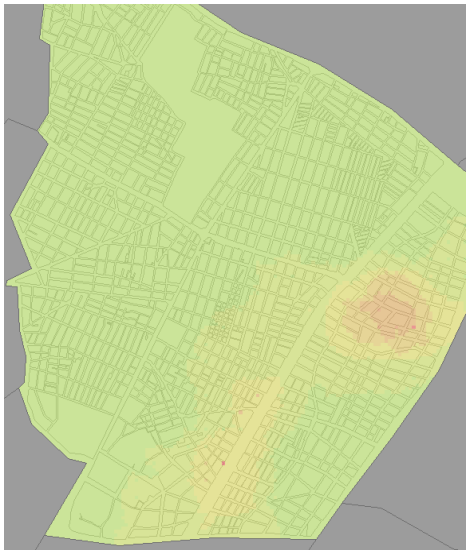
Alternatives' maps present the difference from Base.



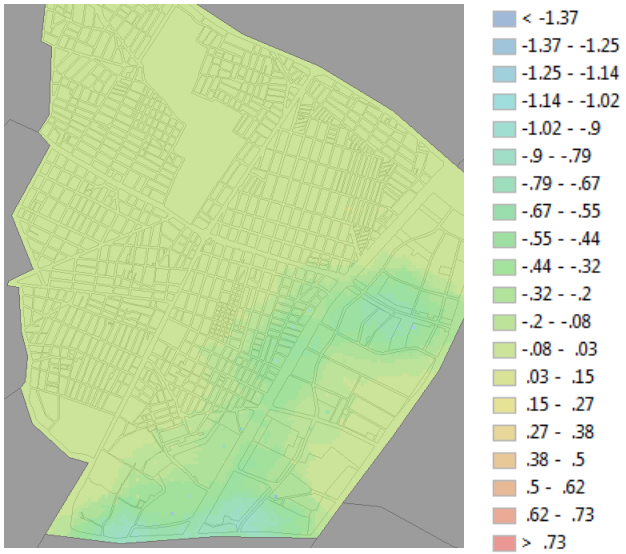
Base



Alternative 1



Alternative 2

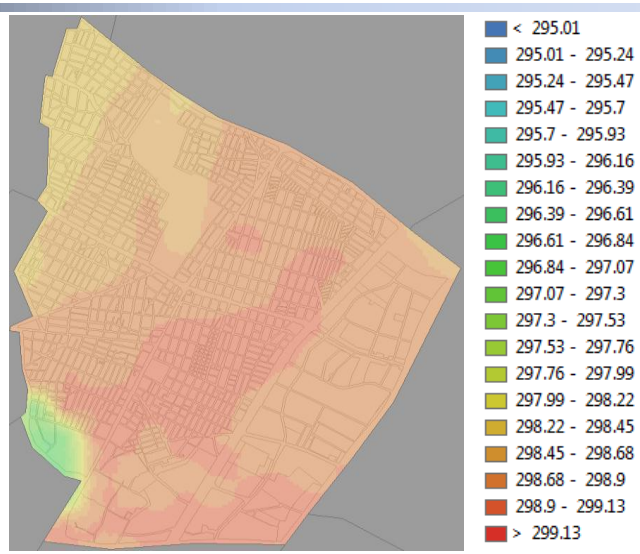


Alternative 3

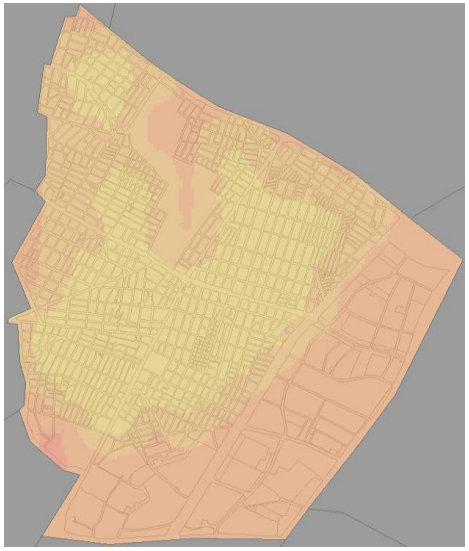
The DSS Outputs – Thermal Comfort

Athens.
Mean air temperature (K)
20:00 - 23:00 LST
in **Summer**.

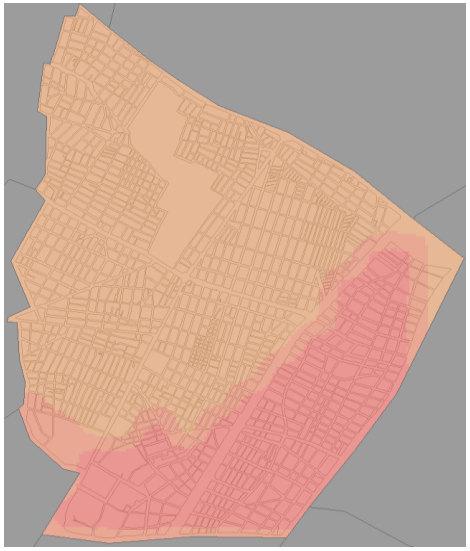
Alternatives' maps present the difference from Base.



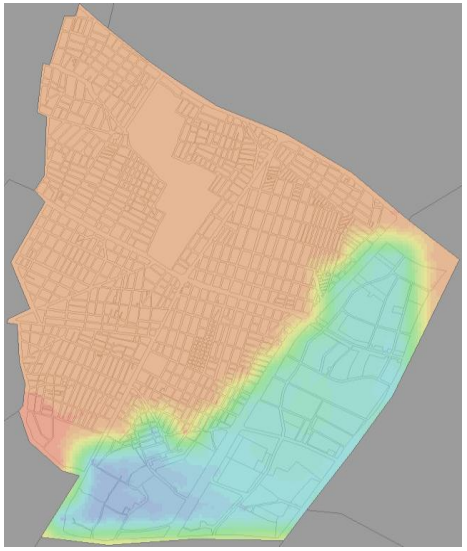
Base



Alternative 1



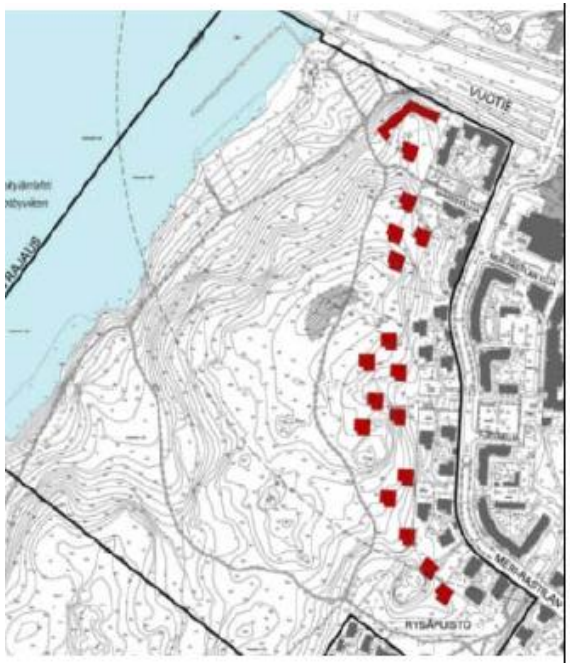
Alternative 2



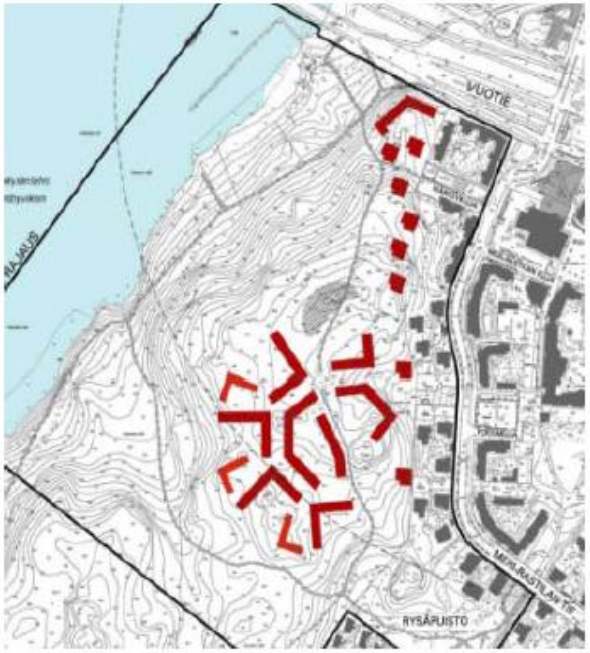
Alternative 3

The DSS Outputs – indicators maps

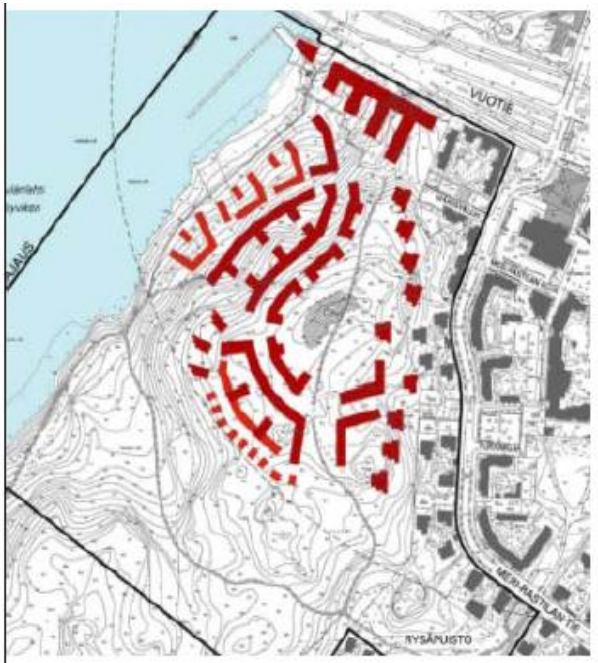
Helsinki Planning Alternatives:



Buildings for 500 inhabitants



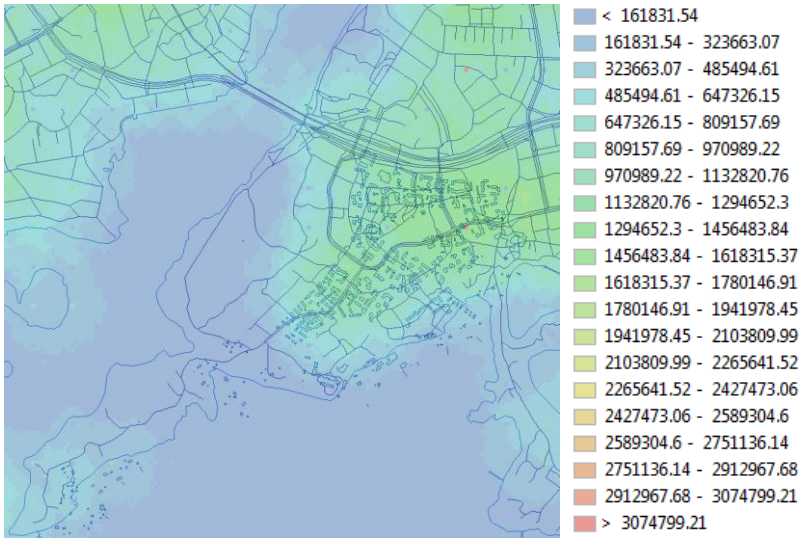
Buildings for 1500 inhabitants



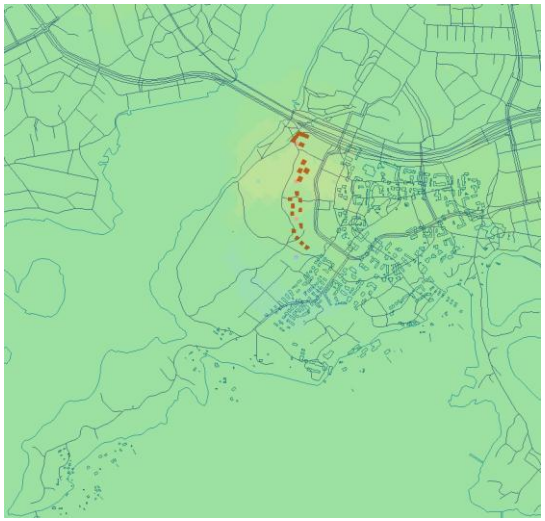
Buildings for 1800 inhabitants and 1000 new jobs

The DSS Outputs – CO_2 Flux

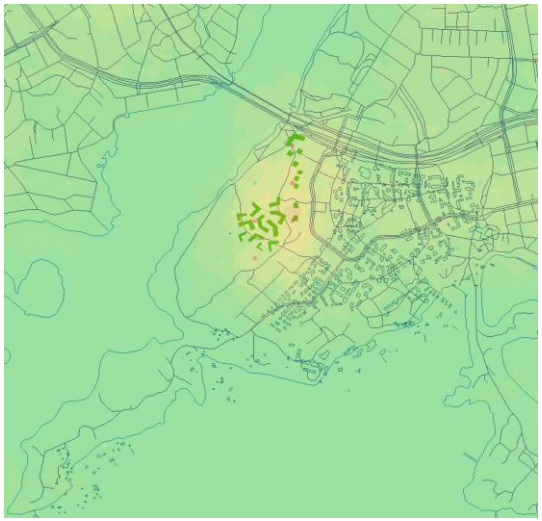
Helsinki.
Yearly cumulative CO_2 emissions (μg/m²).
Alternatives' maps present the difference from Base.



Base

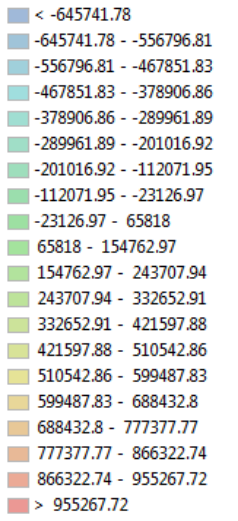


Alternative 1

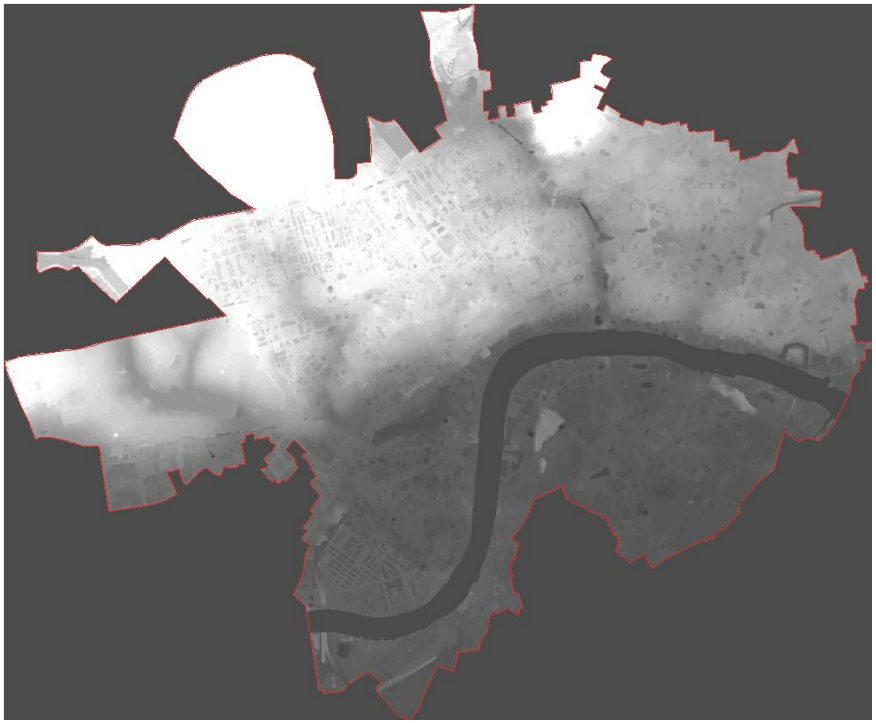


Alternative 2

Alternative 3



The DSS Outputs – indicators maps



London Planning Alternatives:

Alternative 1: Add new street trees.

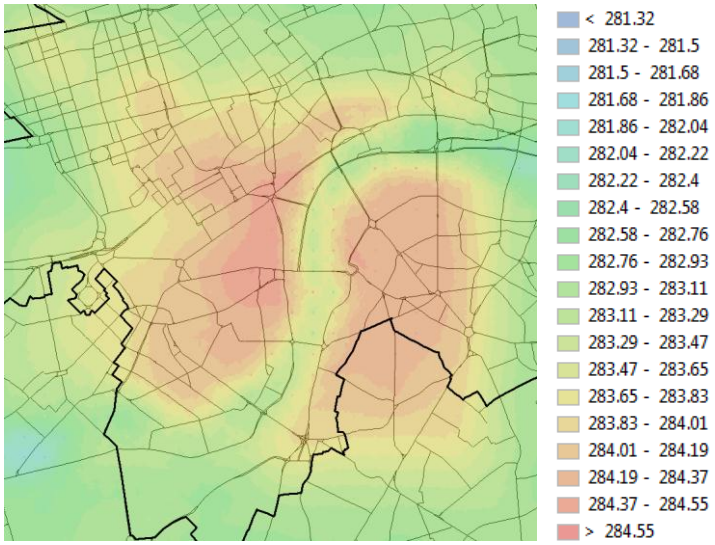
Alternative 2: Add green roofs with varying slopes.

Alternative 1: Implementation of both.

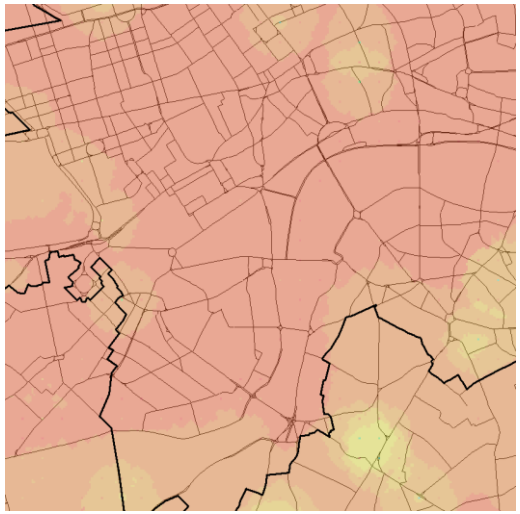
The DSS Outputs – Air Temperature

London.
Yearly mean evening (19:00 – 23:00 LST) air temperature (K).

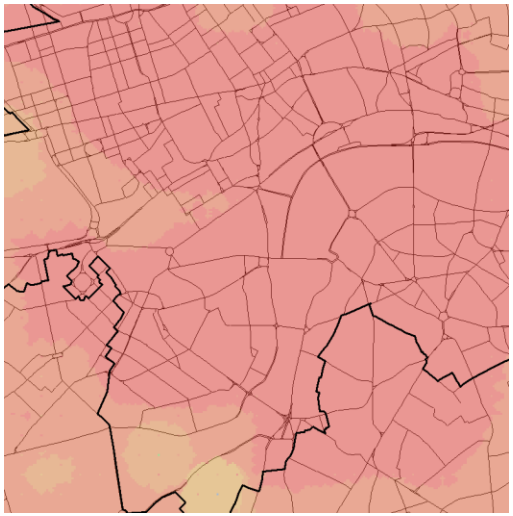
Alternatives' maps present the difference from Base.



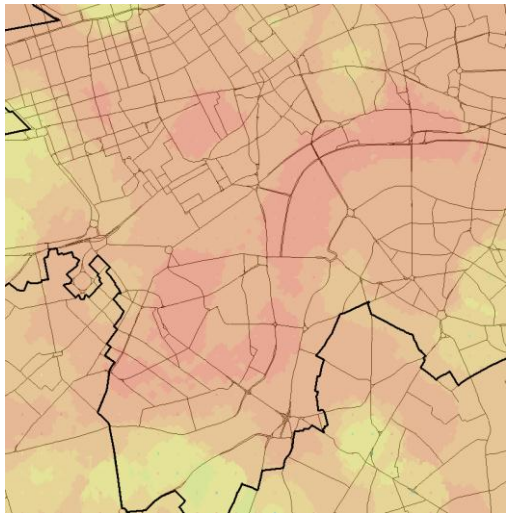
Base



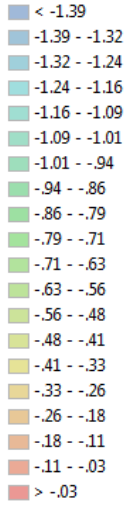
Alternative 1



Alternative 2

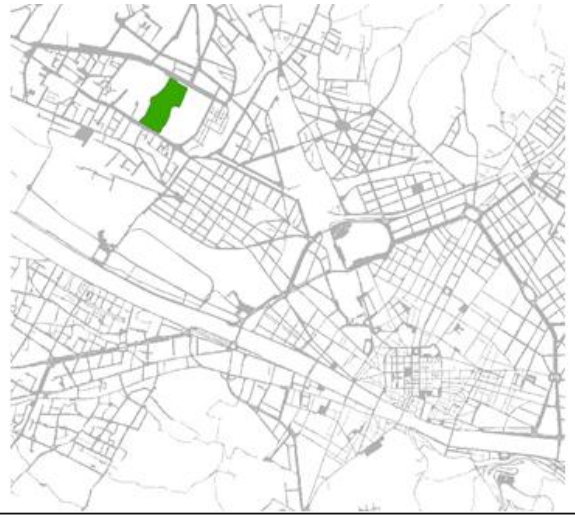


Alternative 3



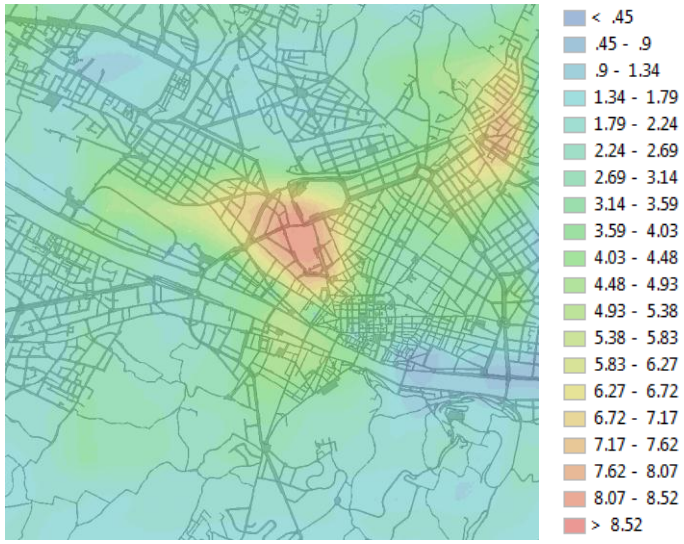
The DSS Outputs – indicators maps

Firenze Planning Alternatives:

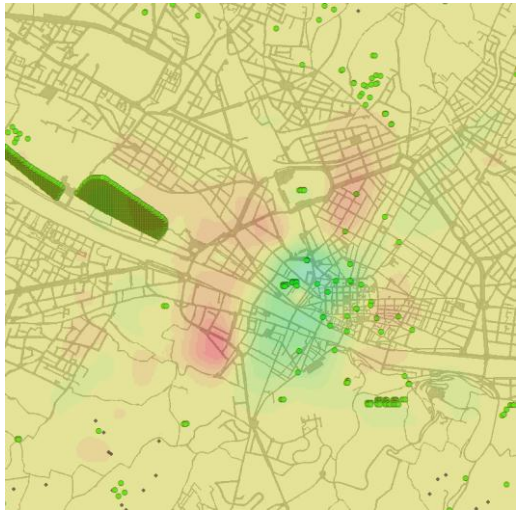
		
Complete reforestation of a green area and a sport arena in the Cascine Park. Increase of trees (deciduous) by about 75% of the total.	Redevelopment of a former industrial area (FIAT) in the north of the Cascine Park, San Donato Park.	Implementation of both.

The DSS Outputs – Surface Runnoff

Firenze.
Mean surface runoff (mm/h) for **Summer**.
Alternatives' maps present the difference from Base.

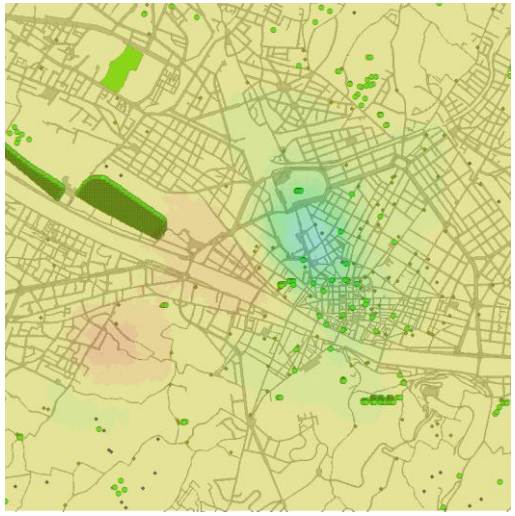


Base



Alternative 1

Alternative 2



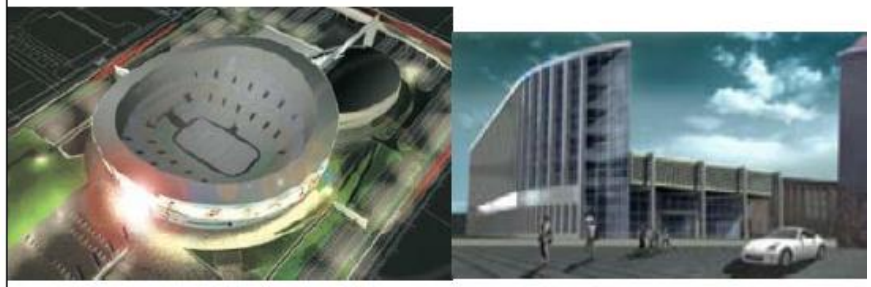
Alternative 3

The DSS Outputs – indicators maps

Gliwice Planning Alternatives:

Sports Centre

a Centre for New Technologies

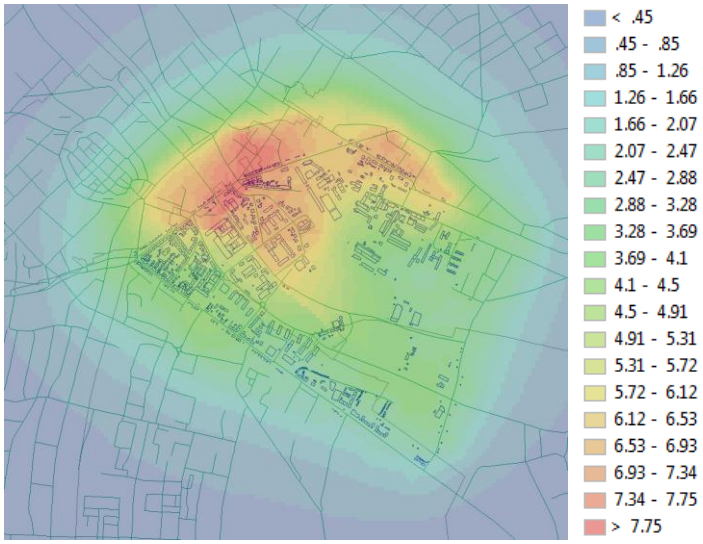


Sports Centre & Centre for New Technologies

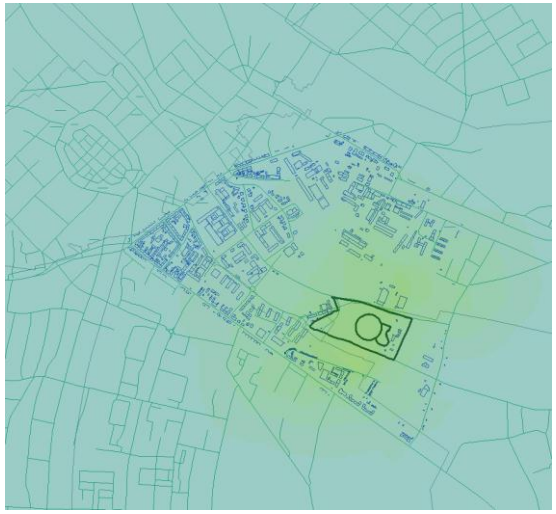
The DSS Outputs – PM_{10} Concentration

Gliwice.
Yearly mean PM_{10} concentration ($\mu g/m^3$).

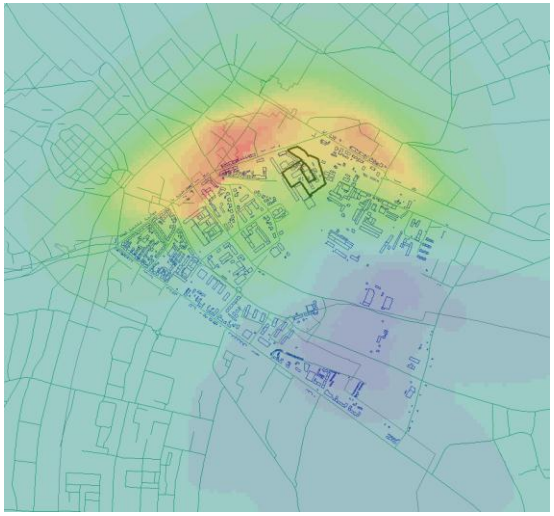
Alternatives' maps present the difference from Base.



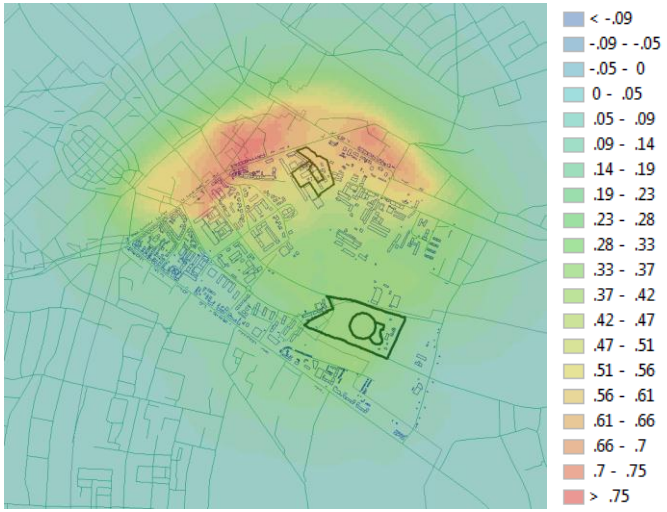
Base



Alternative 1



Alternative 2



Alternative 3

Strategic Scenarios

	Climate Change	Energy / Technological Development	Economy
1	+	+	+
2	-	+	+
3	+	-	-

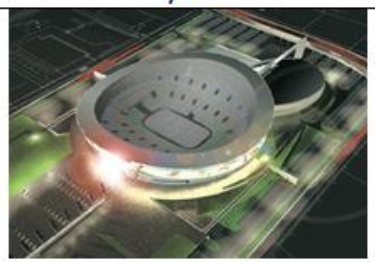
Scenario 1

Scenario 2

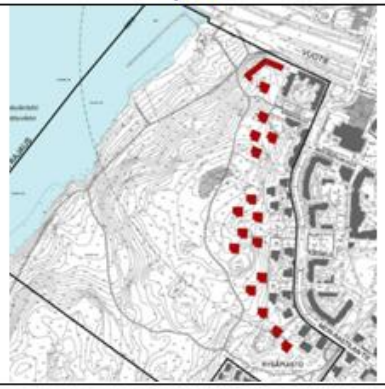
Scenario 3

Strategic Scenarios Analysis

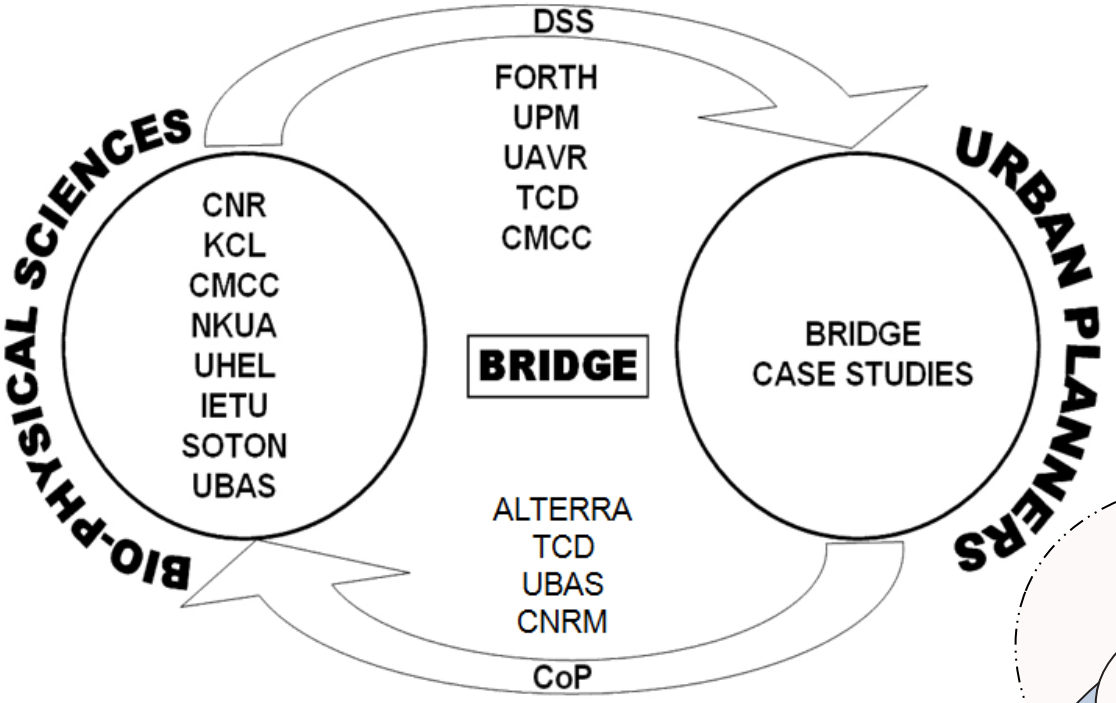
- Gliwice:

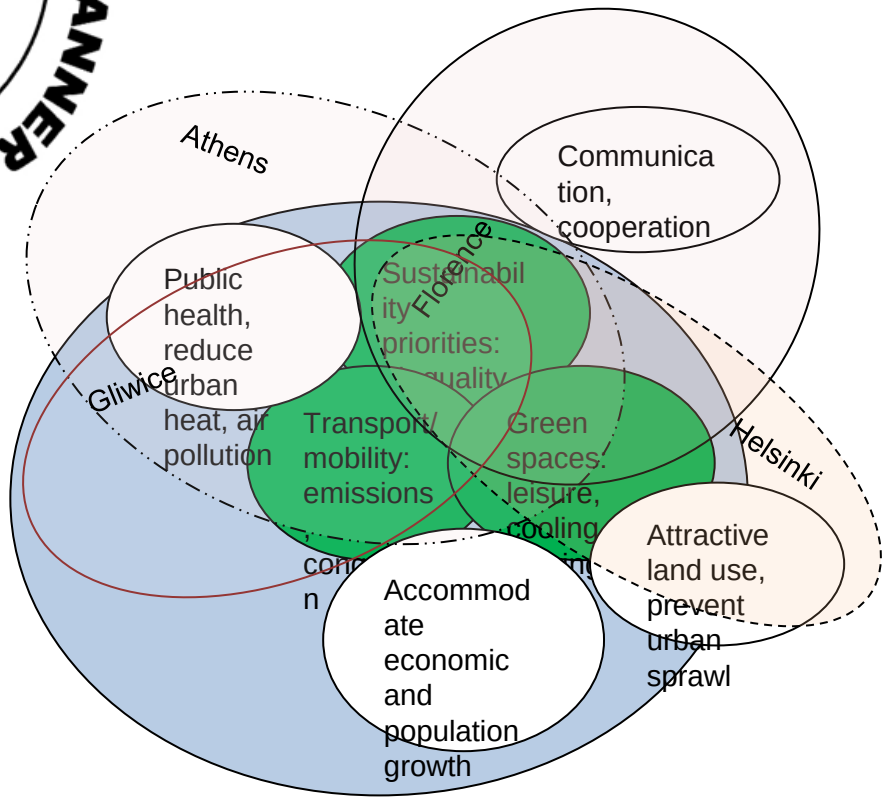
	PA I	PA II	PA III
S I	1,00	1,01	1,33
S II	1,00	1,02	1,05
S III	1,00	1,08	1,37
			

- Helsinki:

	PA I	PA II	PA III
S I	1,00	0,99	0,98
S II	1,00	1,10	1,12
S III	1,00	1,14	1,15
			

The role of users





Conclusions – Future Plans

- BRIDGE evaluates how planning alternatives modify urban metabolism components and is able to promote sustainable planning strategies by enhancing planning processes through the quantitative assessments of environmental aspects on a pair with socio-economic considerations.
- If BRIDGE makes clear what information municipalities need to gather in order to assess environmental sustainability, it will have accomplished a major task.
- Future plans: towards to an operational tool based on BRIDGE DSS Prototype.

http://www.bridge-fp7.eu