

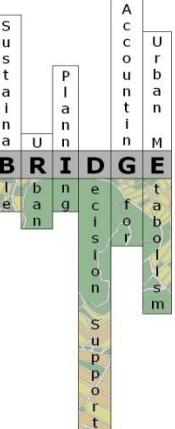
BRIDGE

Main achievements

Meeting of Coordinators
Brussels, October 22-23, 2012.

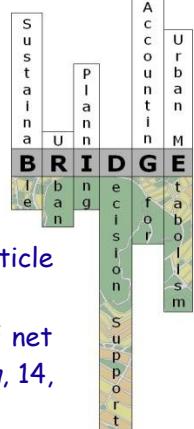


Nektarios Chrysoulakis
FORTH



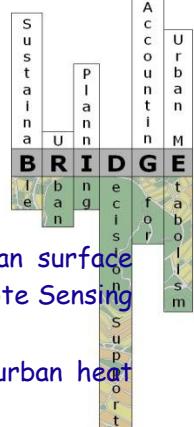
Overview of the main achievements

- Urban metabolism definition based on EWC fluxes.
- CoP meetings (H, L, A, F, G) and umbrella meeting
- Decision making methodology development.
- BRIDGE indicators list development
- Numerical modeling of baseline and alternatives.
- DSS Prototype development.
- DSS evaluation and demonstration.
- Guidelines for sustainable planning strategies.



Publications in scientific journals

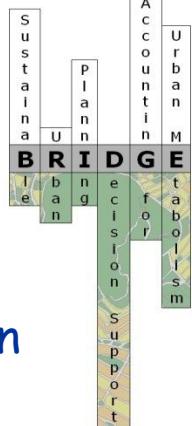
1. Järvi, L., Rannik, Ü., Mammarella, I., Sogachev, A., Aalto, P. P. , Keronen, P., Siivola, E., Kulmala, M., and Vesala, T., 2009. Annual particle flux observations over a heterogeneous urban area. *Atmospheric Chemistry and Physics Discussions*, 9, 13407 - 13437.
2. Järvi, L., Mammarella, I., Eugster, W., Ibrom, A., Siivola, E., Dellwik, E., Keronen, P., Burba, G., and Vesala, T., 2009. Comparison of net CO₂ fluxes measured with open- and closed-path infrared gas analyzers in urban complex environment. *Boreal Environmental Research*, 14, 499 - 514.
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 Stanislawska, 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.
10. 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: Model development and evaluation. *Theoretical and Applied Climatology*, DOI: 10.1007/s00704-010-0382-8.
11. Loridan, T., Grimmond, C.S.B., Offerle, B.D., Young, D.T., Smith, T., Järvi, I. 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.



Publications in scientific journals

12. Mitraka, Z., Chrysoulakis, N., Kamarianakis, Y., Partsinevelos, P. and Tsouchlarakis, 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*.
13. Gobakis, K., Kolokotsa, D., Synnefa, A., Saliari, M., Giannopoulou, K. and Santamouris, M., 2011. Development of a model for urban heat island prediction 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*.
17. Prastacos, P., Chrysoulakis, N. and Kochilakis, G., 2011. Urban Atlas, land use modelling and spatial metric techniques. 51st European Congress of the Regional Science Association International. European Regional Science Association. Barcelona, Spain, August 30 - September 3.
18. A. Riikonen, L. Lindén, M. Pulkkinen and E. Nikinmaa 2011. Post-transplant crown allometry and shoot growth of two species of street trees. *Urban Forestry & Urban Greening*, 10, 87-94.
19. Tallis M., Taylor Gail, Sinnett D., Freer-Smith P. 2011 Estimating the removal of atmospheric particulate pollution by the urban tree canopy of London, under current and future environments. *Landscape and Urban Planning* 103, 129-138.
20. Loridan T & CSB Grimmond Multi-site evaluation of an urban land-surface model: intra-urban heterogeneity, seasonality and parameter complexity requirements. QJRMS doi: 10.1002/qj.963
21. Loridan T & CSB Grimmond (2011) Characterization of energy flux partitioning in urban environments: links with surface seasonal properties *Journal of Applied Meteorology and Climatology* doi: 10.1175/JAMC-D-11-038.1
22. Iamarino M, Beevers S, CSB Grimmond (2011) High Resolution (Space, Time) Anthropogenic Heat Emissions: London 1970-2025 *International Journal of Climatology* DOI:10.1002/joc.2390
23. Lindberg F & CSB Grimmond (2011) Nature of vegetation and building morphology characteristics across a city: influence on shadow patterns and mean radiant temperatures in London Urban Ecosystems doi:/10.1007/s11252-011-0184-5 AllenL, F Lindberg, CSB Grimmond (2010) Global to city scale model for anthropogenic heatflux, *International Journal of Climatology* doi: 10.1002/joc.2210
24. Järvi L, CSB Grimmond, A Christen (2011) The Surface Urban Energy and Water Balance Scheme(SUEWS): Evaluation in Vancouver and Los Angeles. *Journal of Hydrology* 411,219-237doi: 10.1016/j.jhydrol.2011.10.001
25. Loridan T, CSB Grimmond, BD Offerle, DT Young, T. Smith, L Järvi, F Lindberg. Local-Scale Urban Meteorological Parameterization Scheme (LUMPS): longwave radiation parameterization & seasonality related developments. *Journal of Applied Meteorology & Climatology*. 50: 185-202 doi: 10.1175/2010JAMC2474.1.

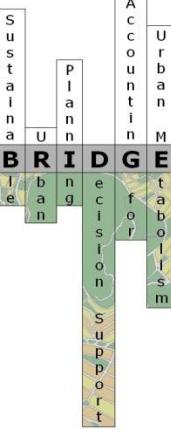
Recent publications



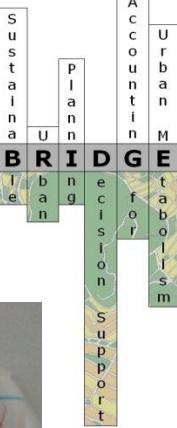
- González, A., Donnelly, A., Jones, M., Chrysoulakis, N. and Lopes, M., 2013. A Decision-Support System for Sustainable Urban Metabolism in Europe. *Environmental Impact Assessment Review*, 38, 109 -119.
- Chrysoulakis, N., Lopes, M., San José, R., Grimmond, C.S.B., Jones, M.B., Magliulo, V., Klostermann, J.E.M., Synnefa, A., Mitraka, Z., Castro, E., González, A., Vogt, R., Vesala, T., Spano, D., Pigeon, G., Freer-Smith, P., Staszewski, T., Hodges, N., Mills, G. and Cartalis, C., 2013. Sustainable urban metabolism as a link between bio-physical sciences and urban planning: the BRIDGE project. *Landscape and Urban Planning* (accepted).
- Mitraka, Z., Diamantakis, E., Chrysoulakis, N., Castro, E., San Jose, R., Gonzalez, A. and Blecic. I., 2013. Prototyping a Spatial Decision Support System accounting for the exploitation of bio-physical sciences in urban planning. *Decision Support Systems* (submitted).

The main demonstration event

- Brussels, October 2011.



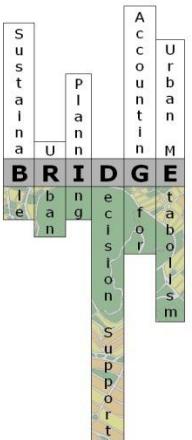
Demonstration beyond the end of the project



- FRENZ Sandpit on ICT Tools for Governance and Policy Modelling



Book Publication by Earthscan



TITLE: Understanding urban metabolism: a tool for urban planning.

Editorial Board: N. Chrysoulakis, E. Castro, E. Moors

PART I: Introduction.

Chapter 1: Urban metabolism.

Chapter 2: Decision support tools in urban planning.

Chapter 3: The BRIDGE approach.

PART II: Measurements and modelling of physical flows.

Chapter 1: In-situ data collection and analysis.

Chapter 2: Remote sensing data collection and analysis.

Chapter 3: Meso-scale meteorological models.

Chapter 4: Air quality models.

Chapter 5: Urban energy budget models.

Chapter 6: Urban water budget models.

PART III: The socioeconomic components.

Chapter 7: A participatory methodology for stakeholders involvement.

Chapter 8: Socioeconomic data collection and analysis.

Chapter 9: Combining environmental and socioeconomic data.

PART IV: The BRIDGE DSS

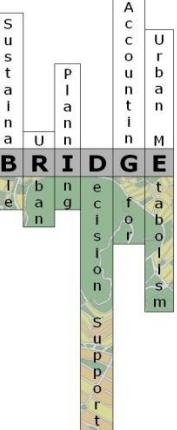
Chapter 10: The BRIDGE impact assessment framework.

Chapter 11: The BRIDGE DSS.

Chapter 12: Application: from scenarios analysis to guidelines development

PART V: Conclusions

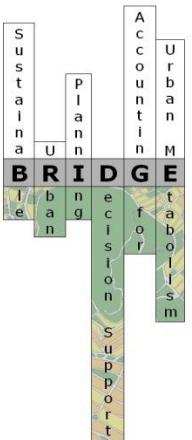
Chapter 13: Conclusions.



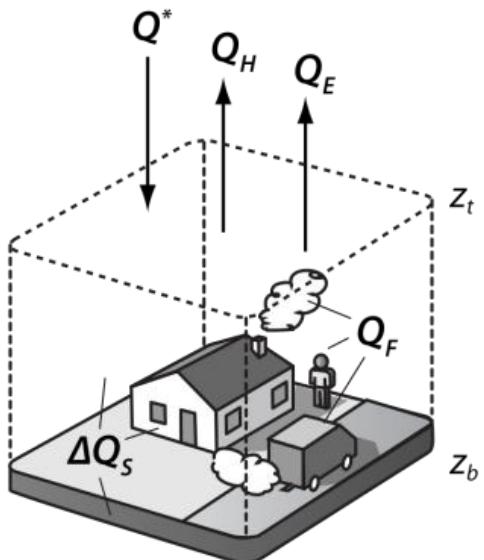
Why BRIDGE?

- 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.

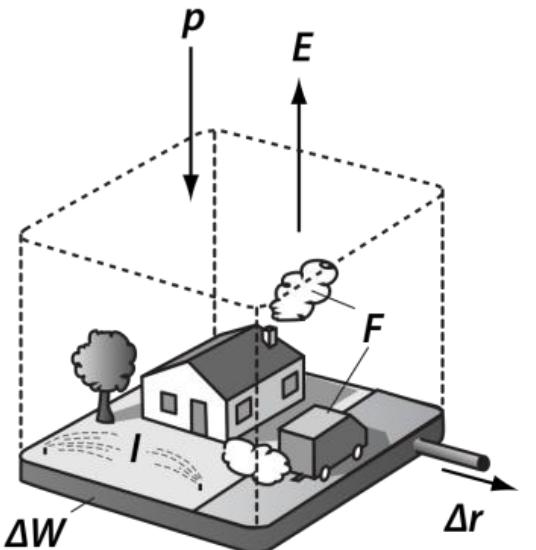
Energy, water and carbon fluxes



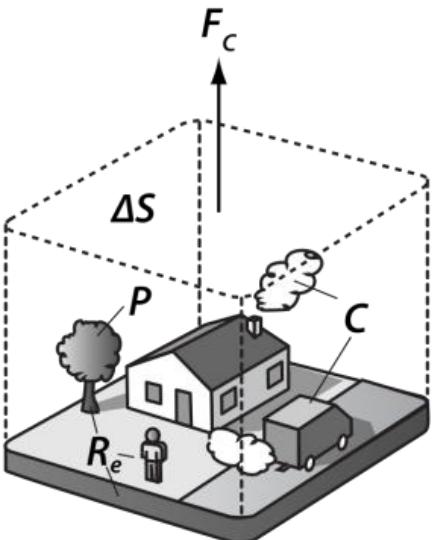
(a)



(b)



(c)

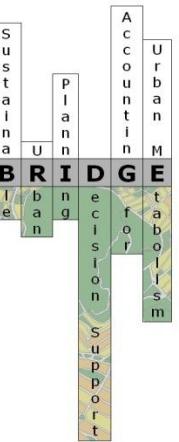


$$Q^* + Q_F = Q_H + Q_E + \Delta Q_S$$

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

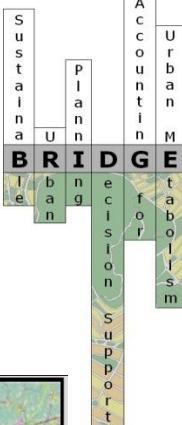
$$F_C + \Delta S = C + R_e - P$$

The BRIDGE idea

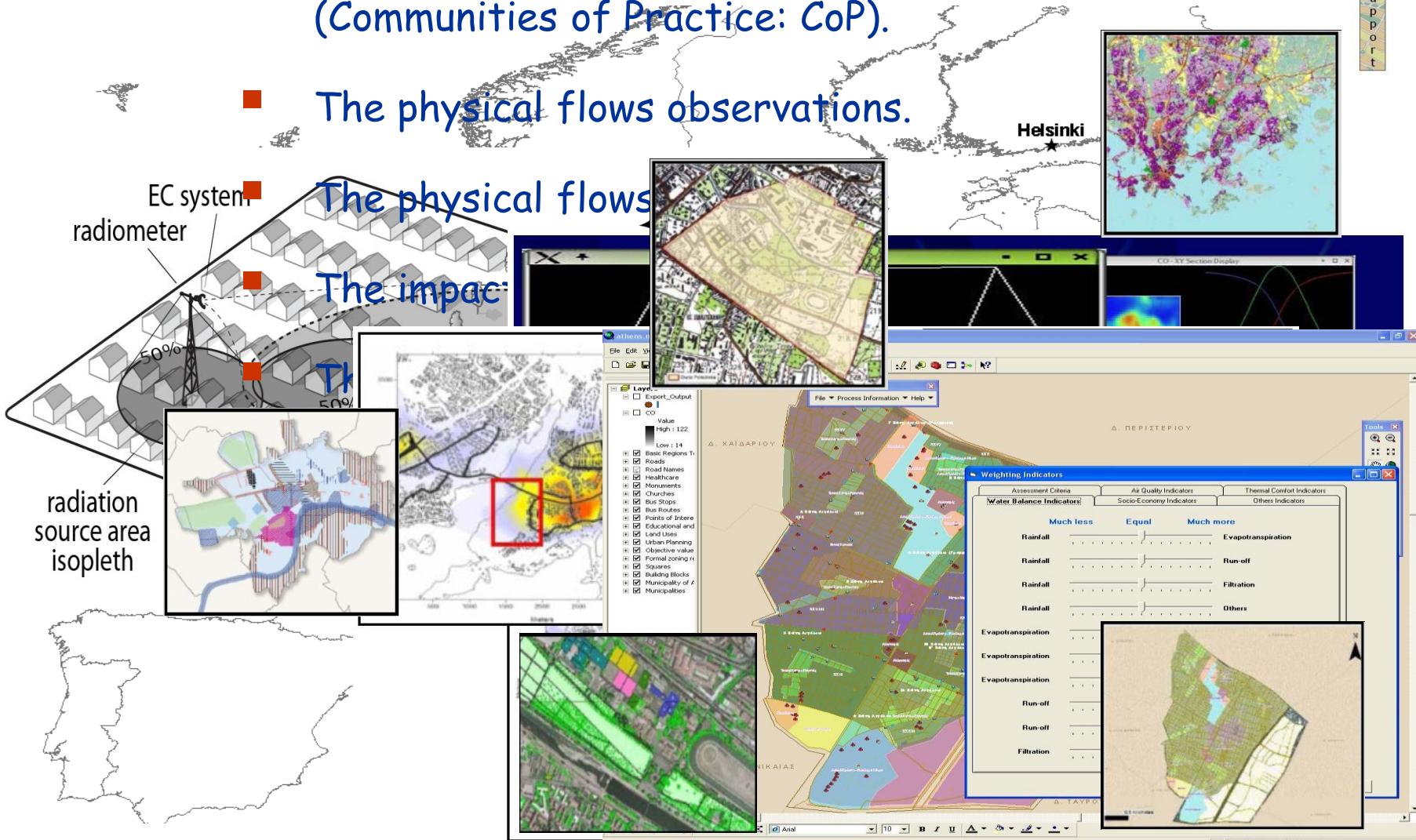


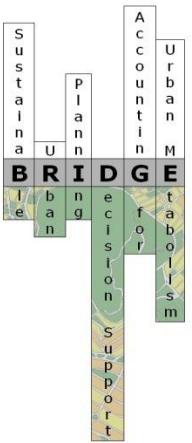
- To define urban metabolism by means of energy, water, carbon and air pollution fluxes in local scale.
- To examine how the **change of land use** and resources use affects the above fluxes.
- To develop **indicators** to quantify their **impacts**.
- To develop a **DSS** based on these indicators.
- 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



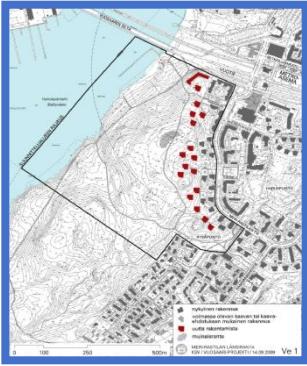
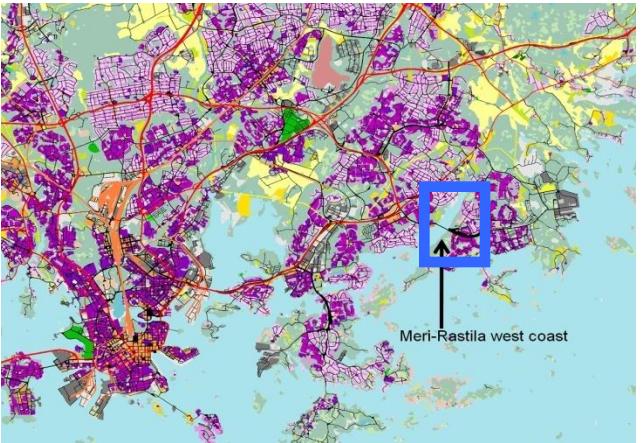
- The involvement of users
(Communities of Practice: CoP).
- The physical flows observations.



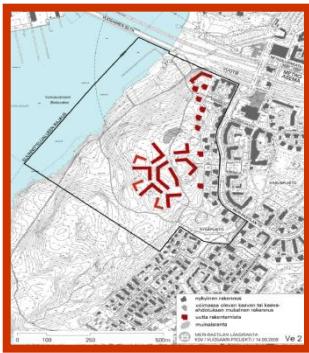


The planning alternatives

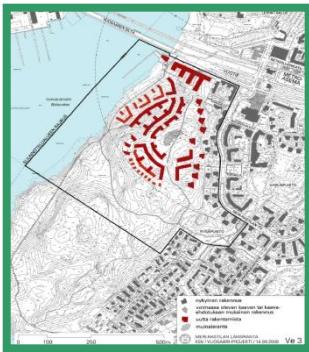
Helsinki:
Meri-Rastila



Alternative 1:
Supplementing the existing blocks

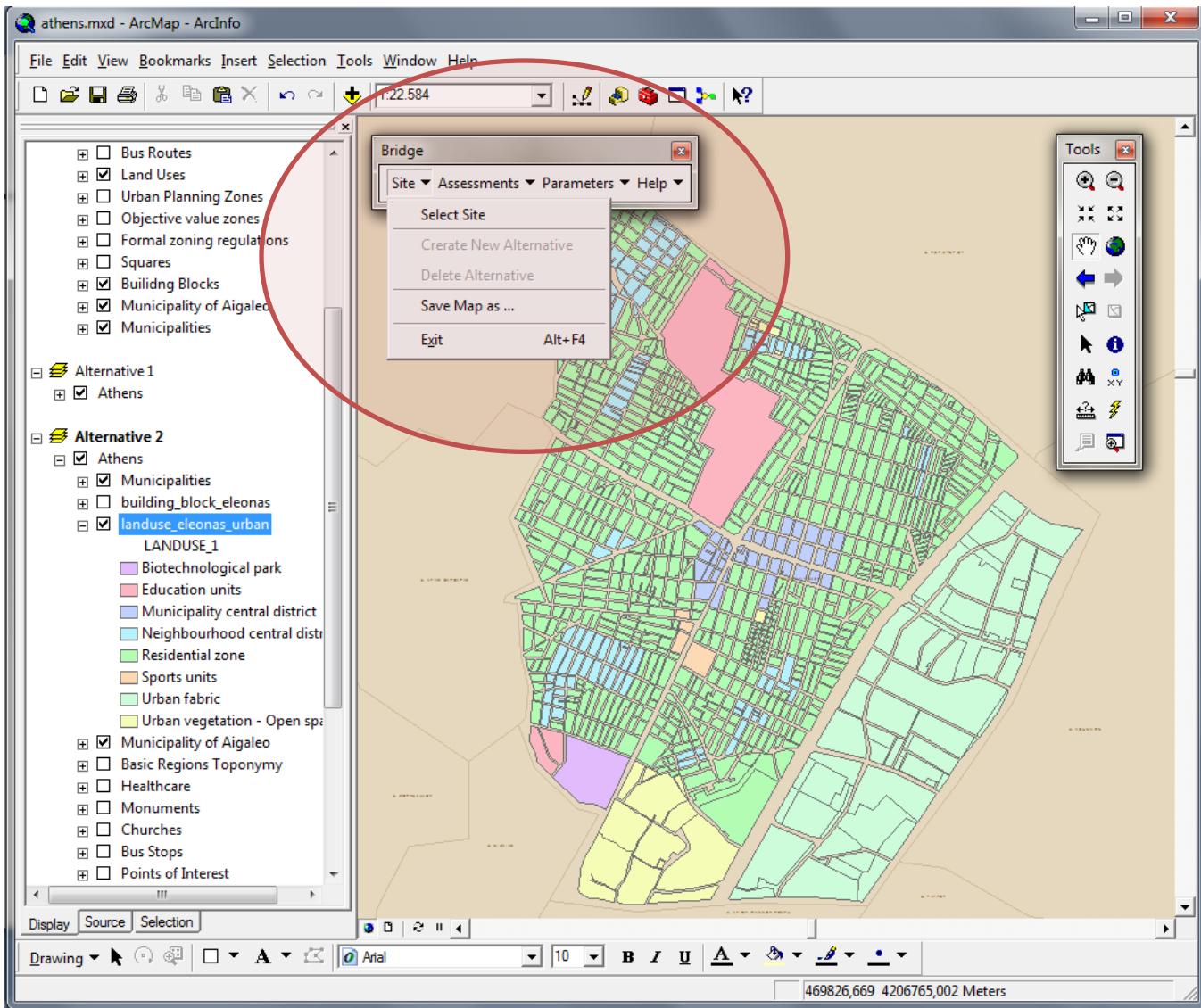


Alternative 2:
Rastilla Hill

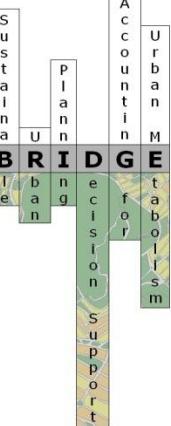


Alternative 3:
Coastal Rastilla

The BRIDGE DSS



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



The BRIDGE DSS

Form1

Environmental

Air Quality

- Pollutant Concentrations
- Green House Gases
- Ambient Concentrations
- Population Exposure to air pollution

Water Balance

- Water Consumption
- Evapotranspiration
- Infiltration
- Surface run-off
- Potential flood risk

Economic

- Cost of proposed development
- Effects on local economy (employment)
- Effects on local economy (revenue)

Social

Land Use

- New urbanized areas
- Brownfields re-used
- Density of development

Mobility/Accessibility

- Quality of pedestrian
- Length of cycle-ways provided
- Length of new roads provided
- Use of public trasport
- Number of inhabitants with access to public transport

Social Inclusion

- Numberof inhabitants with access to services
- Numberof inhabitants with access to social housing

Human well-being

- Number of inhabitants affected by flash flooding
- Number of inhabitants affected by heat waves

Sustainability Dimensions

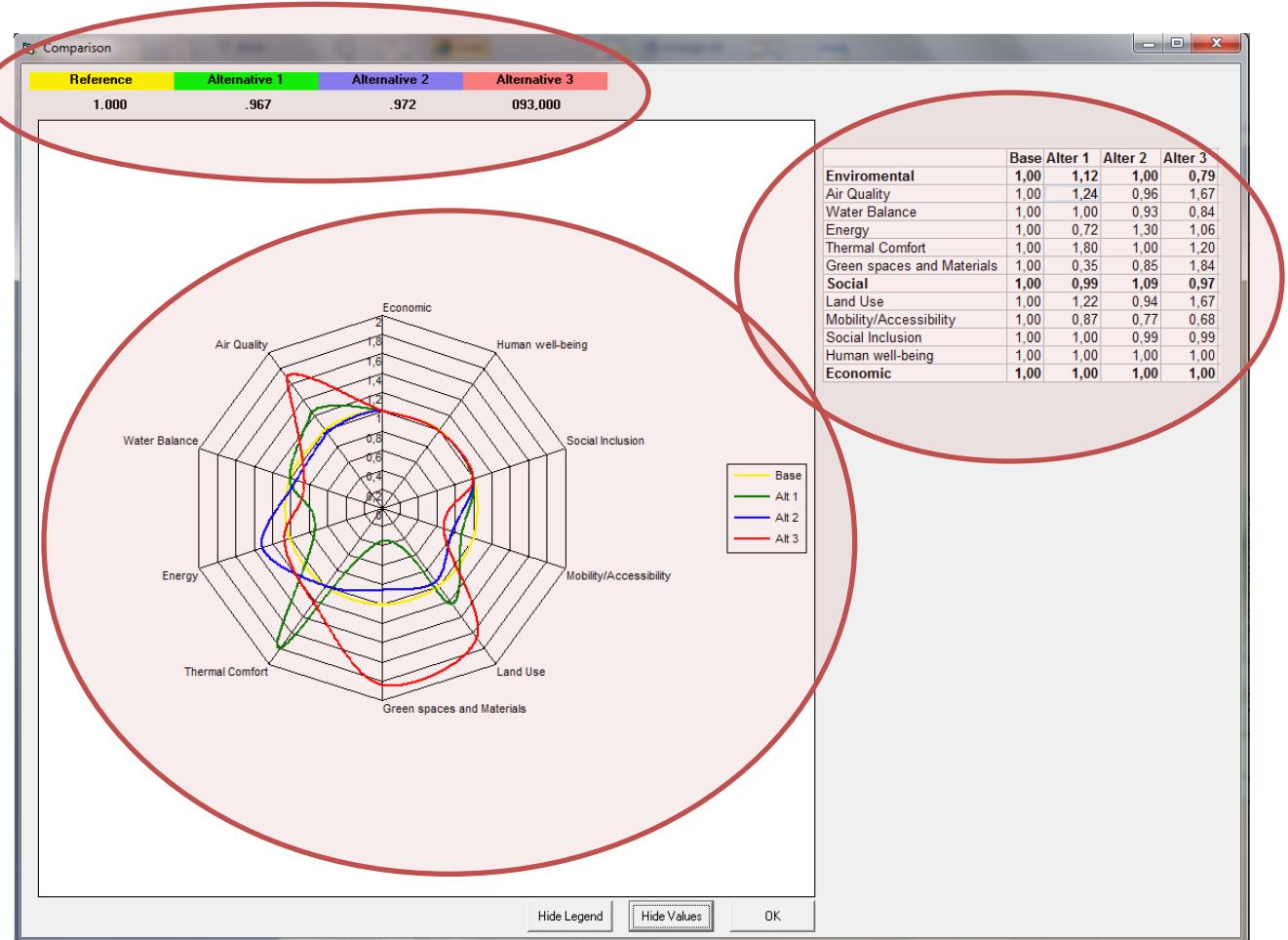
Sustainability Dimensions Weights

OK

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

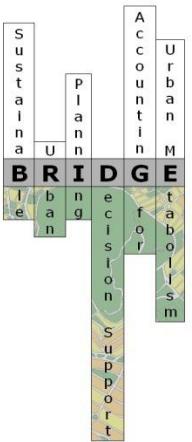
The DSS Outputs - alternatives scores

Through the multi-criteria evaluation process...

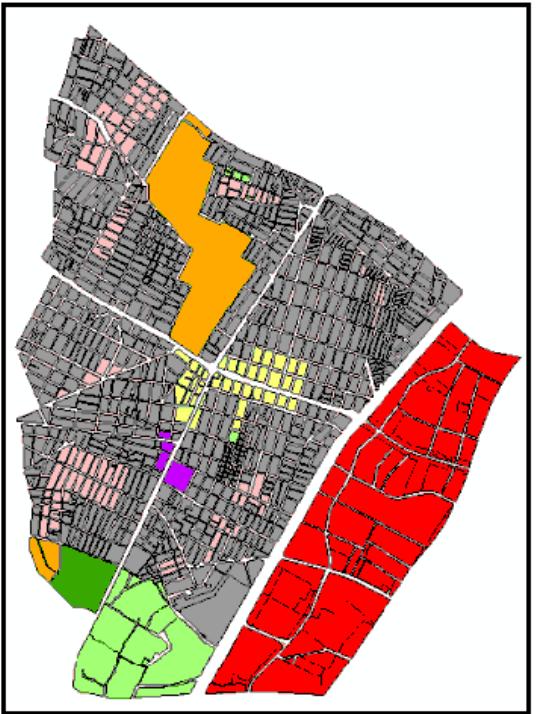


- a *final appraisal score* for each alternative is computed
- and the *sub-scores* computed are also presented as numbers
- and in the form of a *spider diagram*

The DSS Outputs - indicators maps

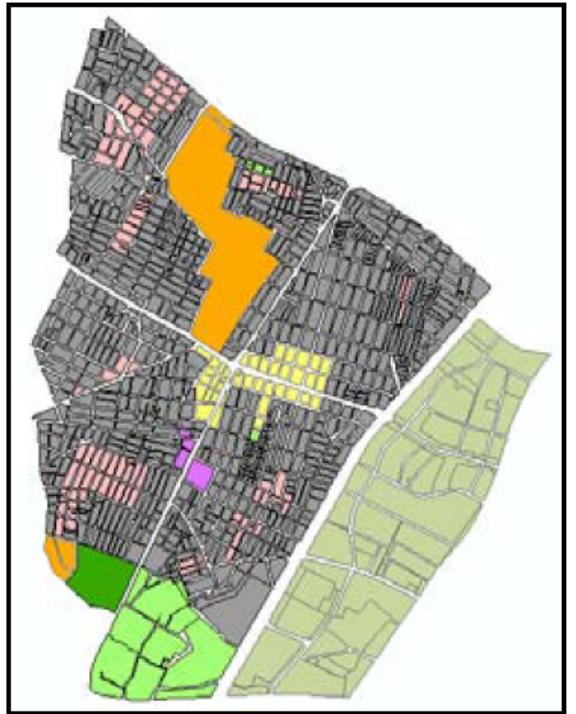


Athens Planning Alternatives:



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 - Thermal Comfort

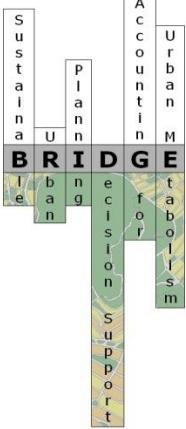
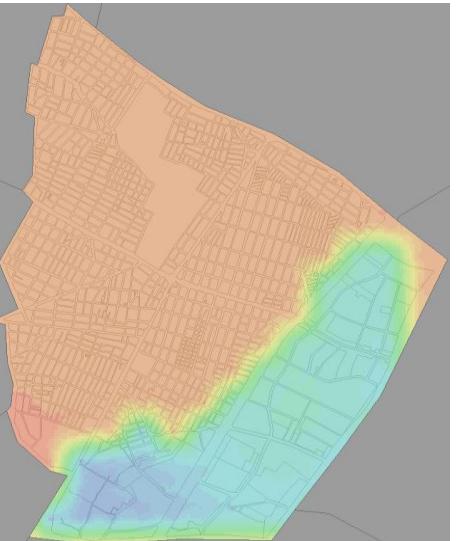
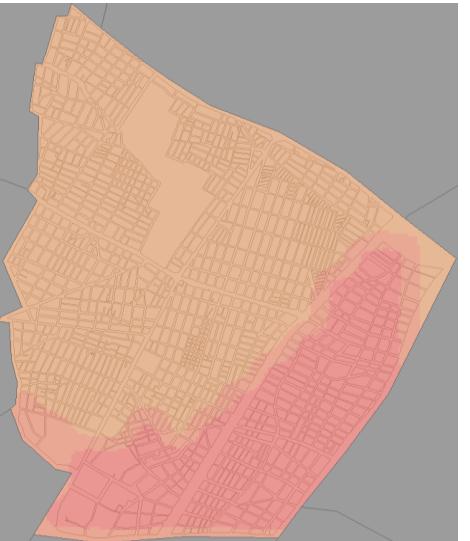
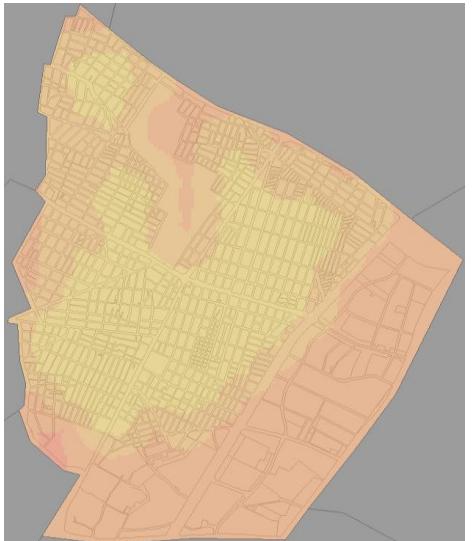
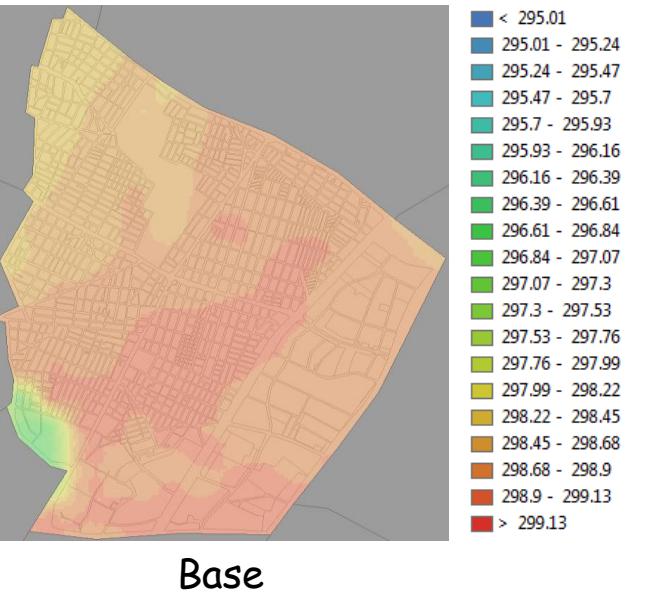
Athens.

Mean air temperature (K)

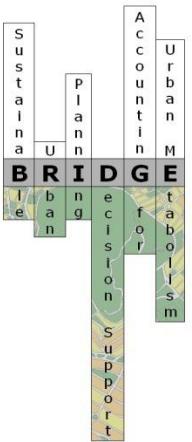
20:00 - 23:00 LST

in Summer.

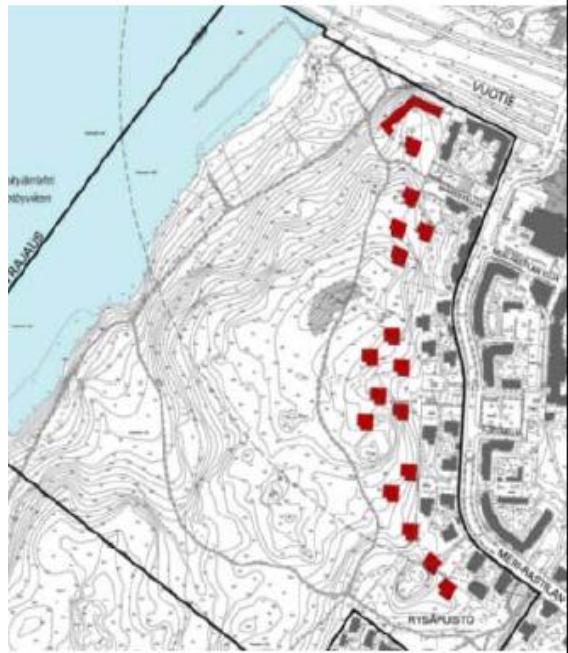
Alternatives' maps
present the difference
from Base.



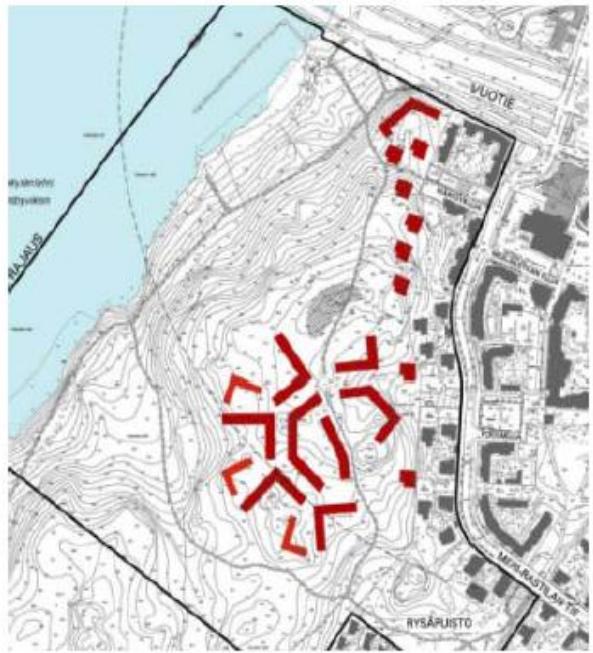
The DSS Outputs - indicators maps



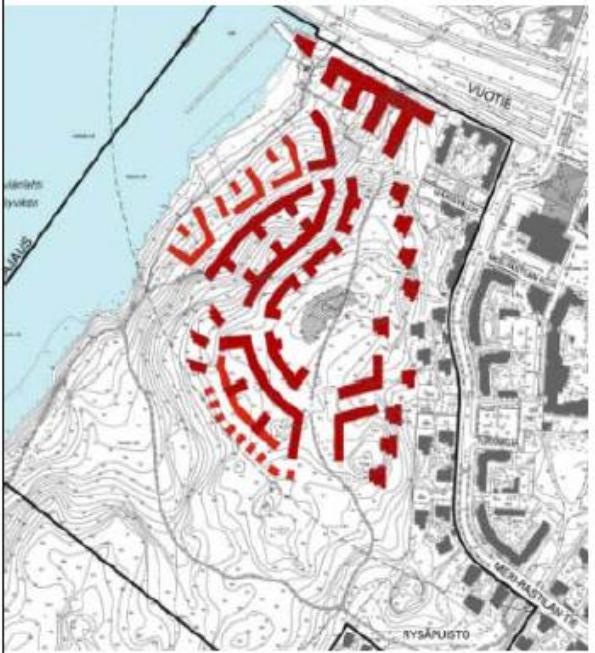
Helsinki Planning Alternatives:



Buildings for 500 inhabitants



Buildings for 1500 inhabitants



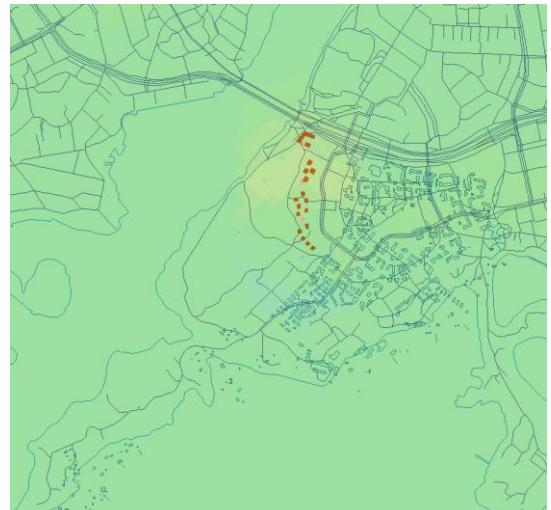
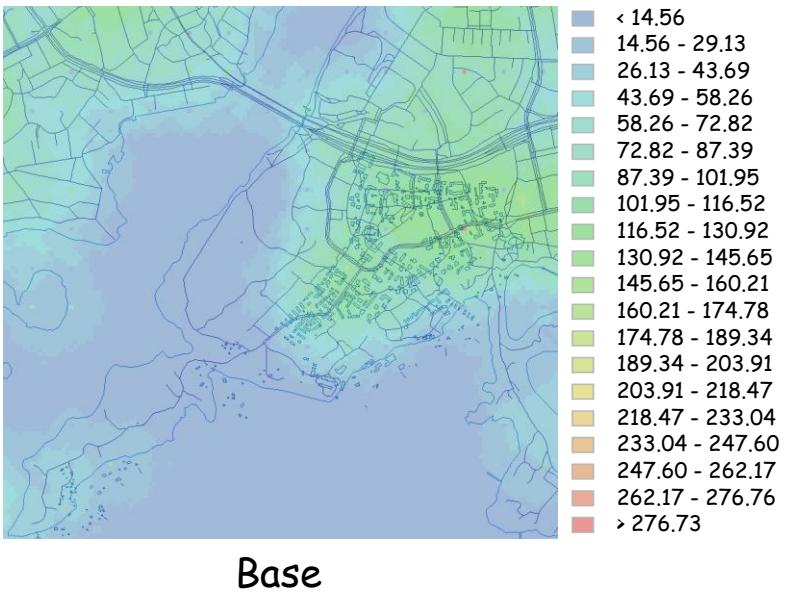
Buildings for 1800 inhabitants and
1000 new jobs

The DSS Outputs - CO₂ Emissions

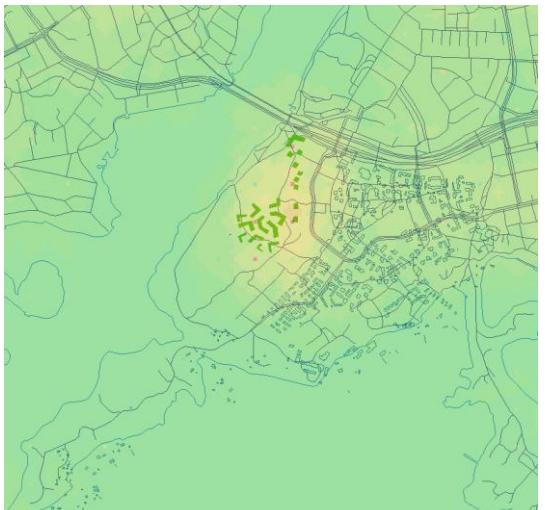
Helsinki.

Yearly CO₂ emiisions.

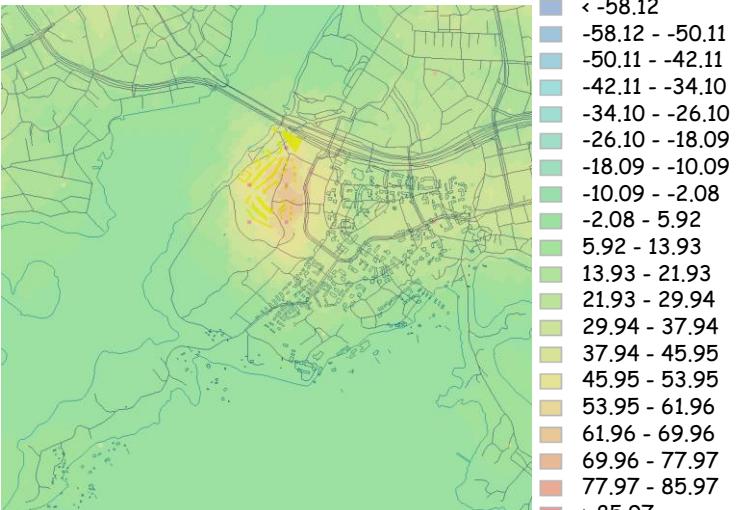
Alternatives' maps present
the difference from Base.



Alternative 1



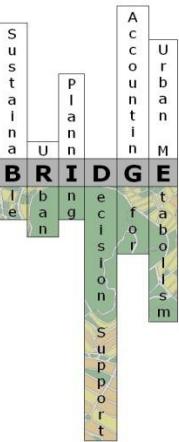
Alternative 2



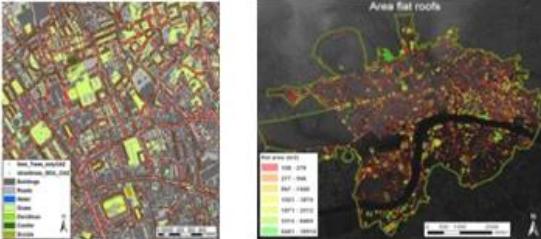
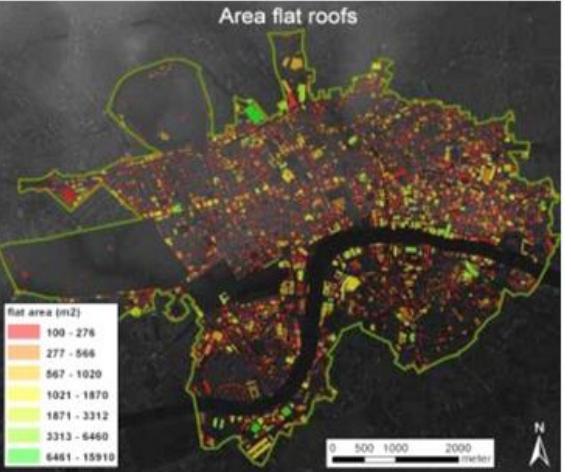
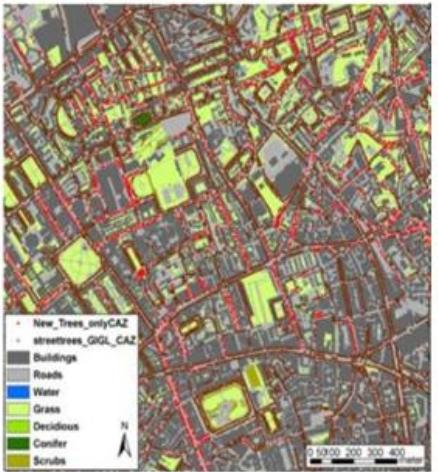
Alternative 3



The DSS Outputs - indicators maps



London Planning Alternatives:



Add new street trees.

Add green roofs (varying slopes).

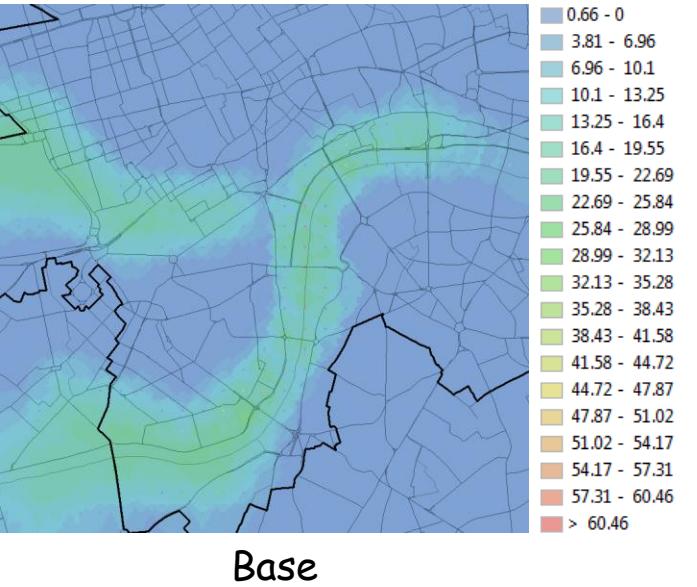
Implementation of both.

The DSS Outputs - Latent Heat Flux

London.

Yearly mean daytime
Latent Heat Flux
(W/m²).

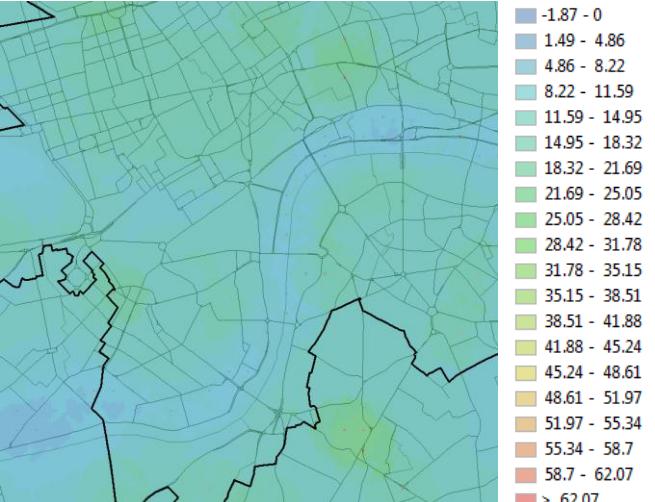
Alternatives' maps
present the
difference from Base.



Alternative 1



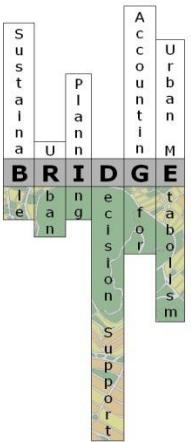
Alternative 2



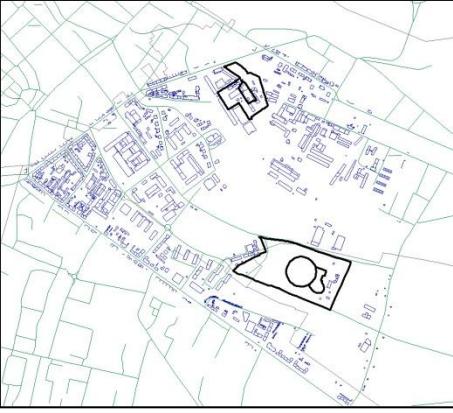
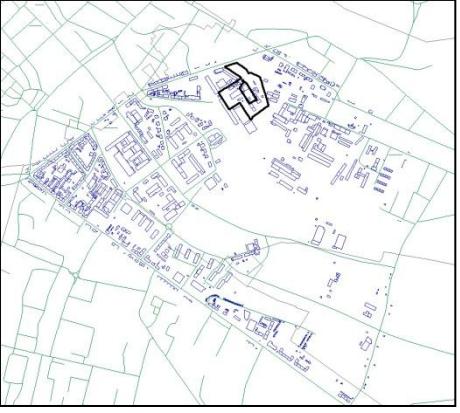
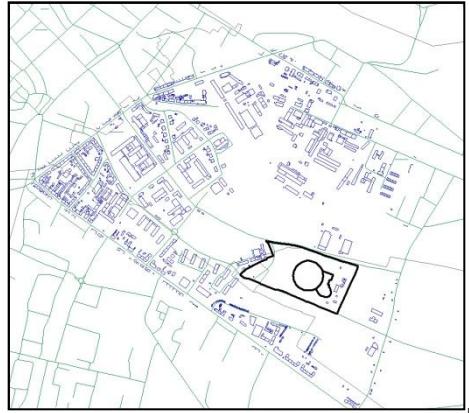
Alternative 3



The DSS Outputs - indicators maps



Gliwice Planning Alternatives:



Sports Centre

a Centre for New Technologies

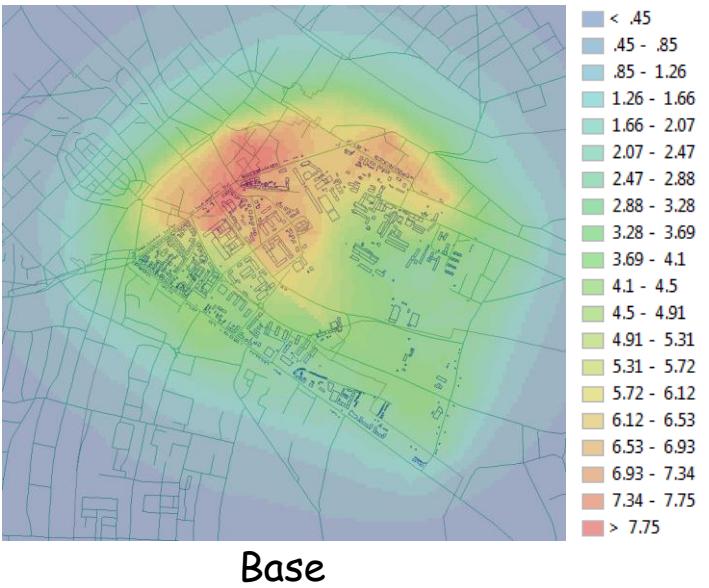
Sports Centre & Centre for New Technologies

The DSS Outputs - PM₁₀ Concentration

Gliwice.

Yearly mean PM₁₀ concentration ($\mu\text{g}/\text{m}^3$).

Alternatives' maps present the difference from Base.



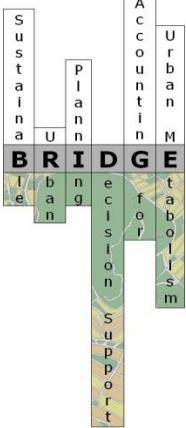
Alternative 1

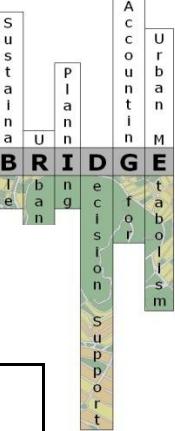


Alternative 2



Alternative 3





Strategic Scenarios

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

Scenario 1



Scenario 2



Scenario 3

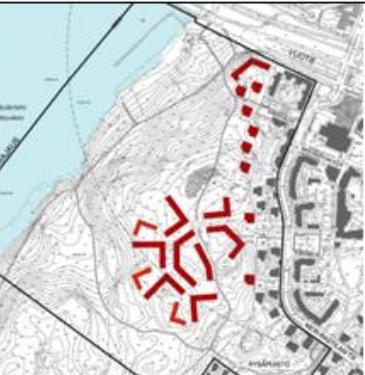


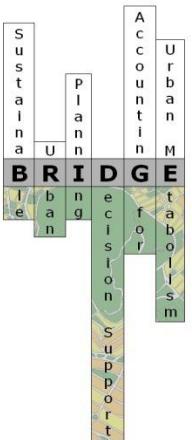
Strategic Scenarios Analysis

Gliwice:

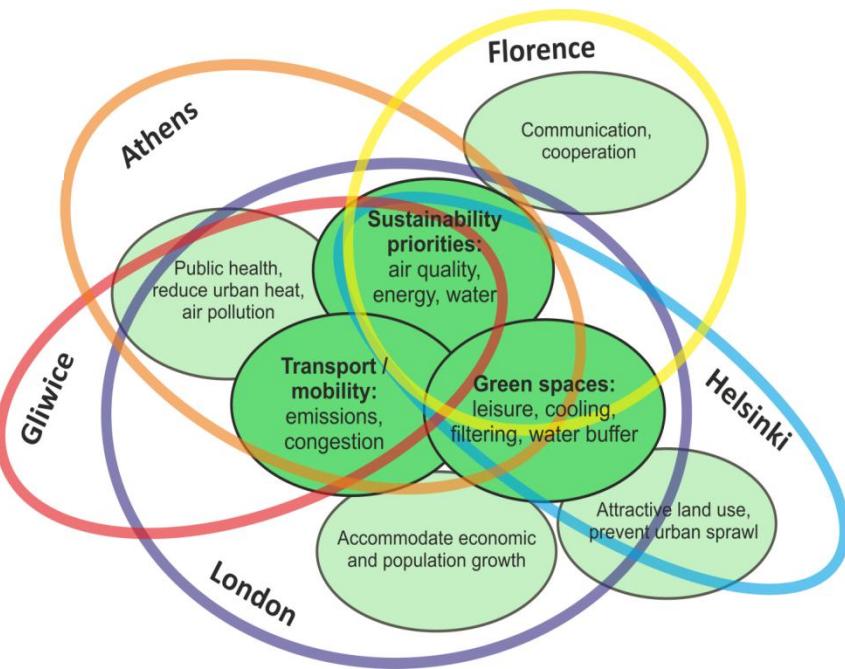
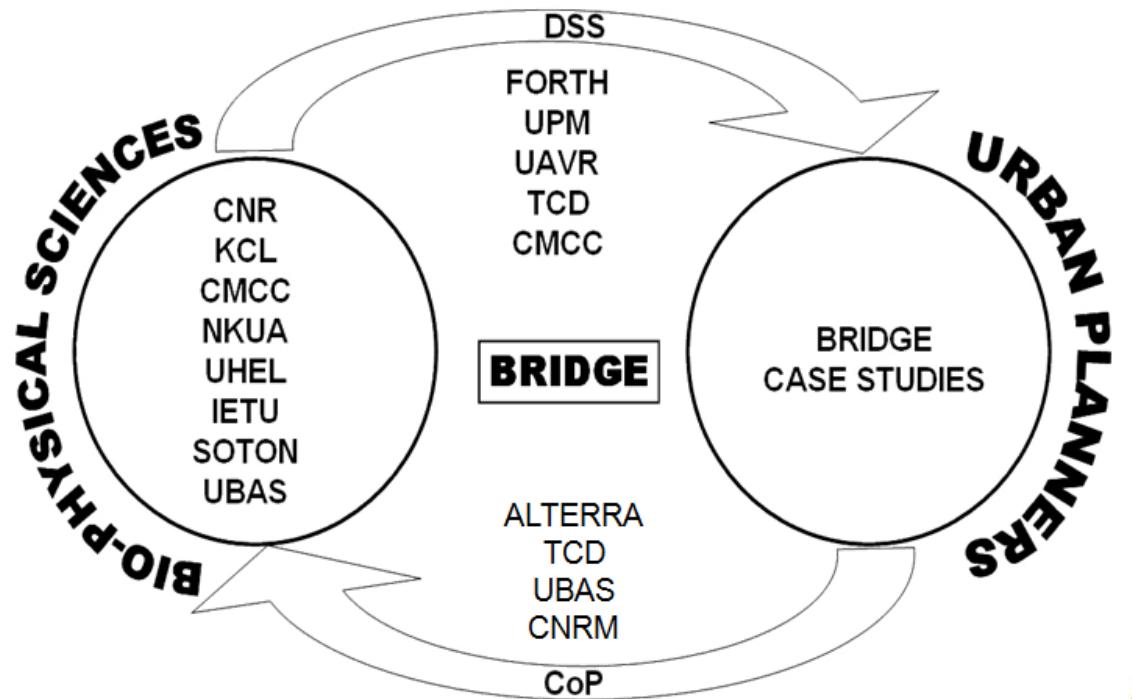
	PA I	PA II	PA III
S I	1,00	1,01	1,33
S II	1,00	1,02	1,05
S III	1,00	1,08	1,37
			

Helsinki:

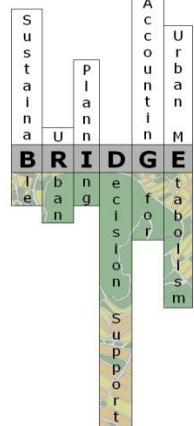
	PA I	PA II	PA III
S I	1,00	0,99	0,98
S II	1,00	1,10	1,12
S III	1,00	1,14	1,15
			



The role of users



Conclusions



- BRIDGE focuses on urban metabolism in its broader sense.
- 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 par with socio-economic considerations.
- By identifying the wide range of information that municipalities need to gather in order to assess sustainability, BRIDGE has accomplished a major task.
- Future plans:
 - ✓ An operational tool based on BRIDGE Prototype.
 - ✓ Exploration of the interplay of UWECE with land use and climate change (Proposal to ENV.2013.6.1-4).
 - ✓ Study of the interactions between UWECE and urban ecosystems services (proposal to FP7-ENV.2013.6.2-5).