5th Urban Research Symposium
Cities and Climate Change: Responding to an Urgent Agenda
Sunday, June 28, 2009
Towards Energy Efficient Cities: Gaining Traction on the Ground

FP 7 Research Project: SUME

Sustainable Urban Metabolism for Europe

Christof Schremmer (ÖIR), Vienna, Austria
Dominic Stead (OTB), Delft, Netherlands

Project partners

01 Austrian Institute for Regional Studies and Spatial Planning (OIR) AT
02 University of Porto, Faculty of Engineering (CITTA – FEUP) PT
03 Nordic Centre for Spatial Development (Nordregio) SE
04 Foundation for Research and Technology – Hellas (FORTH) GR
05 University of Newcastle upon Tyne (UNEW) UK
06 Delft University of Technology (TU Delft) NL
07 Klagenfurt University, Faculty for Interdisciplinary Studies (UNI-KLU) AT
08 Potsdam Institute of Climate Change Research (PIK) DE
09 Chinese Academy of Sciences (CASIA) CN
10 Warsaw School of Economics (SGH) PL
EU-funding: Seventh Research Framework Programme - CP FP7

- Collaborative Research Project
  Area 6.2.1.5 Urban development
- ENV.2007.2.1.5.1 Urban metabolism and resource optimisation in the urban fabric
- Project duration: 36 months 11/2008 – 10/2011
- Project Coordinator: ÖIR - Austrian Institute for Regional Studies and Spatial Planning (Vienna, Austria)

Project objectives

- **Project objectives:**
  Contribute to the reduction of space, energy and material consumption of urban regions
  - through strategies of urban restructuring and urban planning
  - founded on a comprehensive metabolic analysis/modelling

- **Background:**
  - urban growth (population, income)
  - climate change – CO2 reduction objectives
  - high levels of energy-/material consumption in Europe

- **Research on 2 levels:**
  - Urban regions (agglomerations)
  - cities, districts/neighbourhood-level (case studies)

- **Key Words:**
  urban planning – metabolism – built environment – energy consumption – material consumption
Project background –

The challenge ... from past development

Urban Form & growth – Vienna

Correlation between the growth of residential and green areas in Vienna (Austria) from 1958 (left) to 1997

+ 37 %
Urban sprawl in Bratislava (Slovakia) from 1949 (left) to 1997. Only artificial surfaces (class 1 of the Murandy/Moland legend) are depicted.

+ 206 %

Urban sprawl in Palermo (Italy) from 1955 (left) to 1997. Only artificial surfaces (class 1 of the Murandy/Moland legend) are depicted.

+ 211 %
Innovative approach –

The metabolism approach / model

Challenges for urban development, viewed by an urban metabolism approach

- What is the urban metabolic performance of the various (existing) urban structures – in terms of energy use, land use, material input-output balance? (→ GHG, Climate Change)?

- What does urban restructuring mean for a potential future improvement of the energy-material balance? Are there consistently better urban structures/urban forms?

- What is the result of a comprehensive, metabolic appraisal of urban restructuring: What are the material/energy costs of a forced restructuring/rebuilding compared with the use of existing structures?
WP1
Scenarios / dynamics of urban development

Christof Schremmer
ÖIR – Austrian Institute for Regional Studies and Spatial Planning
Vienna

13
28-June-09
5th URS: Cities and Climate Change
Schremmer / Stead

Urban development scenarios – urban dynamics

› Scenarios for a selected sample of cities
› using the urban (building) stock profile as basis
› adding the dimensions of population changes and the potential transformation of the given urban stock - in alternative ways
› .. as a basis for evaluating implications for the urban metabolism (↔ energy consumption, GHG-emissions, land use, material resources ..)
Conclusions from the evaluation of urban development trends/scenarios

- Conclusions from scenarios: Quantitative potential for rebuilding cities
- Conclusions from urban stock typology: Parameters for future types of urban stocks
- Research requirements
WP2 – Urban metabolism and resources

Helga Weisz
PIK - Potsdam Institute of Climate Change Research, Berlin

Julia Steinberger
UNI-KLU – social ecology, Vienna

Urban Metabolism and Resources - Objectives

- Establish links between urban planning and urban metabolism assessment - conceptual and empirical
- screening of criteria used in urban planning with respect to the representation of metabolic considerations
- identifying those resource flows that are relevant environmentally and can be addressed by urban planning
- Advance the urban metabolism approach from a mere flows model to an integrated stocks and flows model
- focus on the determination future resources flows through present urban planning decisions (housing, infrastructure etc.)
- develop a formal model with spatially explicit metabolic profiles for a hypothetical city which can be used in scenario analysis, including the simulation of alternative planning decisions
Electricity use and GHG emissions

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<tr>
<th>Electricity use and GHG emissions (Kennedy, Steinberger et al 2009)</th>
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<tr>
<td>Electricity consumption (GWh)</td>
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Electricity use, GHG intensity and emissions (Kennedy, Steinberger et al 2009)

GHG emissions from ground transport

GHG emissions from ground transportation fuels are inversely related to population density. Kennedy, Steinberger et al 2009
Model of urban metabolism of a hypothetical city

- Dynamic stocks (infrastructure) and flows
  - What infrastructure parameters can be changed, and how fast? (WP1 - urban development scenarios)
  - How can we model the influence of these infrastructure changes on urban resource use (flows) over time?
- Spatially explicit
  - Relevant to transport and/or spatial distribution of urban functions (or socio-economic groups?)
- Overall goal: understanding of interaction of decisive factors in urban metabolism, and how to understand changes

WP3
Impact of urban form and structures on resource use

Paulo Pinho
University of Porto, Faculty of Engineering (FEUP)
**Metabolic Impact Analysis**

- MIA – Metabolic Impact Analysis

- Based on two main components
  (different analytical objects and purposes of analysis)

  - Evaluation methods of urban metabolism
    - European urban system as a framework
    - Metropolitan areas, cities, urban neighbourhoods
  - Evaluation methods of metabolic impact
    - Operational nature
    - Impact of urban interventions - projects/plans/programmes/policies

**Object of analysis**

Focus on the main elements of urban form

- **Stocks** (the following elements of urban form analyzed at 3 different scales – metro, city, neighbourhood)
  - Urban layout / Infrastructures (including blue and green) - integration, connectivity, homogeneity
  - Urban plot - block dimensions, number of plots, functions
  - Buildings - age of buildings, densities, building coverage, alignments and heights, number of households

- **Flows** - generated by activities carried out in the urban context – in particular between super and infrastructures
Porto (case study)

Porto (city)
morphogenetic analysis (1813, 1892, 1948, 2005)
Porto (city)  
axial analysis (1813, 1892, 1948, 2005)

WP 4  
Transforming urban planning and strategies  
Simin Davoudi  
Newcastle University, UK
Transforming urban planning, policies and strategies

- Objectives:
  - To explore how relevant actors, institutions, policies and strategies influence urban structures and hence resource/energy flows
  - To identify the potential for new institutional frameworks and integrated strategies that can shape urban structures in such a way that leads to resource optimisation

How does changing development processes effect Urban Metabolism?

- Development process
  - WP4
- Urban Form
  - e.g. compact, dispersed, monocentric, polycentric
  - WP1, 2, 3
- Urban Metabolism
  - material & energy flows
Key questions

- Who are the key relevant actors and institutions influencing the trajectory of European urban structures?
- What are their roles and responsibilities and interests?
- How do they shape urban development trends and hence urban form/structures and resource flows?
- What are the key strategies and policy tools for regulating urban development?
- To what extent have they influenced the trajectory of European urban forms and restructuring?
- What is the relationship between institutional framework and policy implementation related to the shaping of urban forms/structures?

Conclusion – SUME Outcome Expectations
Expected contributions of SUME to the Climate Change Agenda - 1

Generally
- Raise the level of understanding about the interrelationship between urban form and urban built structures and the level of resources and energy being used.

Specifically, SUME attempts
- to set existing spatial structures in a comparative perspective (types of urban form) and in a dynamic, temporal perspective (types of the speed of growth and urban restructuring);
- to develop a spatially explicit, urban metabolism model, to be used to estimate the influence of various urban forms and development strategies.

Expected contributions of SUME to the Climate Change Agenda - 2

.. plus, SUME attempts
- to evaluate various strategies of transforming existing urban systems into future, metabolically (more) optimal forms (by investing in built structures), by setting the transformation resource input in relation to the resources saved in the operational phase;
- to develop application-oriented impact assessment methods for various urban forms and also for alternative models of future urban forms;
- to evaluate current urban development strategies and actors’ behaviour and
- To find alternative development strategies, thereby taking into account (necessary) incentive structures.
Thank you for your attention!

see online: www.sume.at