Safeguarding urban areas confronting climate trends and extreme weather by means of a trans-disciplinary approach

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Content

Motivation + Aim
Methods + processes
Modifying land use by WSUD
Model scenarios
Mathematical + numerical results
More to come
Members of the network (Acknowledgement)
Motivation

Climate Change

Demographic Change

- Paris
- Aix la chapelle (Aachen)
- Ruhrarea
Motivation

Climate Change

- Temperature [°C]
  - Winter: +3.0
  - Summer: +1.5 up to +3.5

- Precipitation
  - Winter: +5 up to +20 %
  - Summer: ±0 up to -15 %

- Increasing Extremes
  - Rainfall intensity
  - Temperature
  - Duration of events

- Increasing probability of extremes

Prognosticated changes of temperature and precipitation in Europe as result of the MMD-A18 simulations (IPCC, 2007)
### Qualitative Impacts of Climate Change

<table>
<thead>
<tr>
<th></th>
<th>Extreme weather</th>
<th>Shift in the water balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water supply</td>
<td></td>
<td></td>
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<tr>
<td>surface water</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ground water</td>
<td>○</td>
<td>-</td>
</tr>
<tr>
<td>Urban drainage</td>
<td>-</td>
<td>○</td>
</tr>
<tr>
<td>Combined sewage</td>
<td>-</td>
<td>○</td>
</tr>
</tbody>
</table>

- negative; ○ open, + positive
Motivation

Demographic change

Bertelmannstiftung (2006)
Aim

Basic Idea:
**Todays and future changes of urbanization facing migration and demographics in order to initiate adaptation with regard to climate change**

➡️ Water Sensitive Urban Design
Water Sensitive Urban Design

Benefits

- Taking actions now (Stern Report)
- Implementation Water Framework Directive
  - good ecological condition
- Synergies adapting urban design
  - aging population
  - extreme weather (heat and precipitation)
  - land use
  - development of old industrial sites
  - sustainability
- “No regret” measures
Water Sensitive Urban Design

Benefits

- Water in the city
  - appearance
  - micro climate
  - cooling agent, rising evapotranspiration
  - recreation (bathing water quality)
- High wage locations

- today’s standards
  - flooding
  - water quality
  - system reliability
Multi-disciplinary approach

- Urban planning and urban mobility
- Urban water management
- Water supply
- Social Scientists
  - Risk awareness
  - Implementation

Gujer (2002)
Processes

Multi-disciplinary approach

- Urban planning and urban mobility
- Urban water management
- Water supply
- Social Scientists
  - Risk awareness
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Trans-disciplinarity

- Politics
- Administration
- Individual

Gujer (2002)
Methods

Predictability of change

Social studies:

\[ O(t) = \Delta B \cdot (I - r) \]

with:

\[ O \] Output
\[ I \] Input
\[ B \] Intelligence (brain)
\[ r \] resistance
Methods

Predictability of change

Social studies:

\[ O(t) = \Delta B \cdot (I - r) \]

with:

- \( O \): Output
- \( I \): Input
- \( B \): Intelligence (brain)
- \( r \): resistance

Outcome depends on e.g. teamwork
Methods

Predictability of change

Urban hydrology:

\[ Q(t) = \Delta \psi \cdot (Q_i - Q_o) \]

with:

- \( O \) Outflow
- \( Q_i \) Inflow (rain)
- \( Q_o \) int. Outflow (infiltration)
- \( \psi \) runoff coefficient

Outcome depends on e.g. land use, people
Processes

Trans-disciplinary approach

- Stakeholders expectations
- Risk awareness
- Best management practices
- etc.
Processes

The trans-disciplinary paradigm

- trans-disciplinary integration and transfer of knowledge across all stakeholder parties
- implementation using processes on both levels emotional and cognitive
- context related examples, participation of individuals and supervision of success
- evolution of scenarios as subject for transfer of know-how and tuition concepts
- promotion of water sensitive urban design (WSUD)
Processes

The trans-disciplinary paradigm

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Results appear to be very simple
Modeling scenario

Climate models

- Efforts for regionalisation are in progress

First assessment

- 3to5-scenario (rational method)
- hydrologic modeling
Modeling scenario

Combined sewer overflows

→ Szenario:
  ▪ Shift of the water balance from summer to winter of 15 %
  ▪ Increase of extreme precipitation of 15 % in summer
  ▪ constant annular precipitation
  ▪ changes in evapotranspiration neglected
  ▪ sedimentation during dry weather neglected

→ Catchment data:
  ▪ $A_{ca} = 31$ ha
  ▪ $A_i = 14$ ha
  ▪ 2,900 inhabitants – no industry

→ Hydrologic sewer quality model
  ▪ central basin approach
  ▪ Moment
Results

Hydrologic modeling

![Graph showing spec. storage volume vs. spec. Emitted load by CSO (KgCSB/(ha(i)*a)) for climate change and status quo. The graph includes lines for 0%, 2%, 4%, and 6% increase in (%) with specific storage volume in m³/ha(i).]
Results

3to5-scenario

- 15 min design storm
  - current state: $143.5 \text{ l/(s*ha)} = 0.86 \text{ mm/min}$
  - climate change: $159.8 \text{ l/(s*ha)} = 0.96 \text{ mm/min}$
- increase: about 11%
## Results

**WSUD: Tables for measures for different disciplines**

<table>
<thead>
<tr>
<th>Landuse</th>
<th>Rainwater Harvesting</th>
<th>Reservoir</th>
<th>Infiltration</th>
<th>Roofs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td></td>
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<tr>
<td>Constrains</td>
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<tr>
<td>Effects</td>
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<tr>
<td>Urban development</td>
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<tr>
<td>Water management</td>
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<tr>
<td>Climate/Environmental</td>
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<tr>
<td>Residents/ Property owner</td>
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<tr>
<td>Commune</td>
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</tbody>
</table>
Conclusions

- Traditional solutions in concrete are not the most desirably methods.
- Economic and population changes demand flexible and sustainable solutions wherever possible.
- Adaptation will concern existing systems which are serving well for up to a hundred years.
- Points of interest have favorably to be located at the head to the sewer system. That way disconnection of surfaces, pollution control, retention and infiltration are more effective.
- A first assessment leads to an increase of max. discharge of 11%.
  - WSUD measure are feasible to achieve this goal
Outlook

2nd phase has started

- Residential/commercial area
- Brown field development
- Inner City
Summary

- Climate change and demographics will lead to changes in urban development
- Water management has to be an important part
- For this change people (individuals) need to be involved
- First assessment of the magnitude
  - design level
  - adaptation is possible
  - further research on rare events
- Implementation and acceptance has just started
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www.isa.rwth-aachen.de/klimanet
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