Adaptation measures to control exceeding flow in urban catchments

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Content

1. Introduction
2. Theoretical Approach
3. Integrated Concepts for Rainwater Management
4. Efficiency Assessment Approach
5. Application on a Case Study
6. Conclusion and Outlook
Introduction

IPCC Predicts Rise in Extreme Climate Events (Special Report March 2012)

Hamburg (June 6th 2011, up to 60 l/m² (Hamburg Wasser) in few hours); Source: Dennis Dorendorf
Drivers of Future Development

- Urban Growth
- Climate Change

Increase Stress on Drainage Systems

Make Drainage Systems more Flexible and Robust

Overland Flow Generation

Control and Manage the Exceeding Water
Theoretical Approach

System Understanding

Adaptation Measures

Methods and Tools to Assess Efficiency

Acceptance of the Stakeholders

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Present state

Future Scenarios*)

<table>
<thead>
<tr>
<th>System analysis</th>
<th>Development of an integrated concept for sustainable drainage</th>
<th>Concept to manage the exceedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment of potential areas for adaptation measures</td>
<td>Efficiency assessment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preliminary assessment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Application of mathematical models</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assessment of the cost effectiveness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multi-Criteria Analysis (MCA)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Decision Making</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Successive implementation and review</td>
<td></td>
</tr>
</tbody>
</table>

*) climate change, socio economic projections

Source: Giovanni Palmaricciotti, Natasa Manojlovic, Sandra Hellmers
Integrated Concepts for Rainwater Management

Elements for the Conveyance and Storage of the Exceeding Flow

• Diversion Structures
• Conveyance Structures
• Green Reservoirs
• Multipurpose Spaces
• Underground Storage
Elements for the Conveyance of the Exceeding Flow

- **Diversion Structures**

- Curbs
- Check dams
- Flood abatement systems
- Earth dykes
- Property walls
- Speed bumps

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Elements for the Conveyance of the Exceeding Flow

• Conveyance Structures

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Elements for the Storage of the Exceeding Flow

- Green Reservoirs

Detention basin  Infiltration basin  Retention basin

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Integrated Concepts for Rainwater Management

Elements for the Storage of the Exceeding Flow

- Multipurpose Spaces

- Sport courts
- Play grounds
- Green areas
- Traffic islands
- Small roads
- Parking spots

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Integrated Concepts for Rainwater Management

Multi-Scale Approach (Micro Scale $\rightarrow$ Macro Scale)

Source: Giovanni Palmaricciotti; Sandra Hellmers; Software Application Google Sketchup
Integrated Concepts for Rainwater Management

District level

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Integrated Concepts for Rainwater Management

District level

- Overflow Outlet
- Speed Bump
- Football Court
- Pervious Parking
- Rills
- Green Roofs

- Swales
- Traffic Islands
- Street
- Curbs
- Rainwater Tank

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Integrated Concepts for Rainwater Management

District level

Dry

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Integrated Concepts for Rainwater Management

District level

Event below the Drainage Capacity

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Integrated Concepts for Rainwater Management

District level

Low Frequency Event (above Local Measures Capacity)

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Integrated Concepts for Rainwater Management

District level

Extreme Event

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Retention of Rainwater in a Roundabout Traffic (street level)

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Retention of Rainwater in a Roundabout Traffic (street level)

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Integrated Concepts for Rainwater Management

Retention of Rainwater in a Roundabout Traffic (street level)

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Retention of Rainwater in a Roundabout Traffic (street level)

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Efficiency Assessment Approach

 Hydrological numerical model

• Detailed simulation of the single measures (micro-scale \(\rightarrow\) hydrological response units)

• Interaction of the measures (macro-scale \(\rightarrow\) sub-catchment)

Current Work:
Implementation of the measures with the features of hydrotops (micro-scale), but interacting on the river system plan on the macro-scale.

For more information:
• http://sourceforge.net/projects/kalypso/
• www.tu-harburg.de/wb/forschung/software-entwicklung/kalypso/kalypso-na.html

Source: Sandra Hellmers
Application on a Case Study

Geographic Localization of the Study Area

Source: Giovanni Palmaricciotti, Microsoft Bing Maps, BSU (Hamburg Ministry of Urban Development and Environment)
Problem: Need for a more Robust Drainage System

Source: www.hamburg.de
Application on a Case Study

Analysis of the Study Area

- Topography
- Hydrology
- Soil Properties
- Land Use

Assessment of the Potential for Adaptation Strategies (present and future)

Source: Giovanni Palmaricciotti, BSU (Hamburg Ministry of Urban Development and Environment); Software Application ArcGis
Chosen Focus Block

Source: Giovanni Palmaricciotti, BSU (Hamburg Ministry of Urban Development and Environment); Software Application ArcGis
Application on a Case Study

Example of Conveyance + Storage of Exceeding Water

Source: Giovanni Palmaricciotti, BSU (Hamburg Ministry of Urban Development and Environment); Software Application Google Sketchup, ArcGis
Application on a Case Study

1. Infiltration in Traffic Islands

Source: Giovanni Palmaricciotti; Software Application Google Sketchup

Google Maps
2. Infiltration + Conveyance in Swales

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
3. Temporary Storage in Sport Area

Below Design Event

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
3. Temporary Storage in Sport Area

Extreme Event

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Conclusion and Outlook

• Need for Development of Integrated Concepts for Storm Water Management i.e. Systems which are Able to Cope with Different Return Periods and with Future Scenarios Related Uncertainties (Quantity)

• Need for a Multi-Disciplinary Approach to Analyse the Study Case from Different Points of View (Quality)

• Need for Involvement of the Public in the Decision Making Process (Awareness + Acceptance)

• Need for Legal Regulations (Guidelines)

• Implementation of the Adaptation Measures (Conveyance and Storage Systems) into the Hydrological Model to Assess Efficiency

• Creation of Physical Models to Study and Optimize the Systems and to Compare to Numerical Models
Thank you for your attention
Source-Pathway-Receptor Model

Source

Water course

Receptor

SUDS<sub>i</sub> (design value x<sub>i</sub>)

Pathway

Conveyance of exceedance flow
(for P>design value)

SUDS<sub>i</sub> (design value x<sub>i</sub>)

Source: Giovanni Palmaricciotti; Natasa Manojlovic; Software Application Google Sketchup
Integrative Concepts for Rainwater Management

Elements for the Conveyance and Storage of the Exceeding Flow

• Underground Storage

G-cans project, Tokyo (Japan)

Loop 7, Tokyo (Japan)

TARP, Chicago (USA)

SMART, Kuala Lumpur (Malaysia)
Integrative Concepts for Rainwater Management

Retention of Rainwater in a Roundabout Traffic (street level)

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
1. Infiltration in Traffic Islands

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Application on a Case Study

2. Water Ponding on the Street

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
3. Temporary Storage in Sport Area

Source: Giovanni Palmaricciotti; Software Application Google Sketchup
Example: Water Square Project Rotterdam (De Urbanisten)

During Dry Periods

During heavy Rainfall Events

Source: www.worldarchitecturenews.com