Life cycle assessment of urban stormwater management systems

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Introduction

Subsurface solution

What solution is most sustainable?

Cloudburst Management Plan

→ What solution is most sustainable?

Image sources: Cloudburst Management Plan 2012; Konkretisering af Skybrudsplan for Nørrebro-oplandet
Research questions

- Which approach to stormwater management is most sustainable?
- How does the flood safety target affect the environmental impacts?
- How important are local emissions from runoff in the overall environmental evaluation?
Life Cycle Assessment

- Materials: Process
- Transport: Process
- Construction: Process
- Operation: Process
- Disposal: Process

Input: [L diesel, combusted]

Process

Emission: [kg greenhouse gases]

Impact: [CO2 equivalent]

Normalized impact: [person equivalent]
Nørrebro, Copenhagen

- Densely populated urban catchment
- Commercial, residential, and recreational areas

Image sources: danbolig.dk; oplevbyen.dk; Konkretisering af Skybrudsplan for Nørrebro-oplandet
System design: flood safety levels

Three Points Approach

- **Everyday domain**: Manage runoff separate from wastewater.
  - Rain depth: ~20 mm
  - Return period: 0.2 years

- **Design domain**: Ensure no water on the surface.
  - Rain depth: ~70 mm
  - Return period: 10 years

- **Extreme domain**: Ensure max. 10 cm water on the surface.
  - Rain depth: ~110 mm
  - Return period: 100 years

Environmental impacts

Cloudburst Management Plan
Subsurface alternative
Environmental impacts: sensitivity analysis

- **PE / year**

- **Climate Change**
- **Ionising radiation**
- **Photochem. oxid. form.**
- **Freshwater eutroph.**
- **Marine eutrophication**
- **Resource depl. (fossil)**
- **Terrestrial acidification**
- **Terrestrial eutroph.**

Legend:
- **CMP:** baseline
- **CMP:** pipe construction
- **CMP:** paved areas
- **SSA:** baseline
- **SSA:** pipe construction
- **SSA:** road materials
Allocation to life cycle stages

Material production  Transport  Construction  Operation  Decomm. & disposal
Elements and flood safety

Different elements contribute to fulfilling different flood safety levels.
Allocation to flood safety levels
Climate change impacts

Cloudburst Management Plan

Subsurface alternative

<table>
<thead>
<tr>
<th>PE / year</th>
<th>Cloudburst Management Plan</th>
<th>Subsurface alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unallocated</td>
<td>A Everyday</td>
<td>B Design</td>
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</tbody>
</table>

A Everyday  | B Design  | C Extreme | Unallocated
Ongoing work

Assessment of ecotoxicity impacts

- Stormwater management system 1
- Stormwater management system 2
- Stormwater management system 3

Discharge to freshwater
Discharge to soil
Discharge to WWTP

Emissions
Impacts
Conclusion

• Stormwater management above the surface and using green elements (Cloudburst Management Plan) is more sustainable than a subsurface solution for the Nørrebro catchment.

• The targeted flood safety level influences the environmental impacts.
• Elements not contributing to flood safety cause relatively high impacts.

Preliminary results:
• The untreated discharge of runoff causes high ecotoxicity impacts.
• The use of filter soil reduces these impacts significantly.