Urban storm water management

Cooperation between geologists and land-use planners

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Background

- Urban flood modeling has become more topical during 21st century
  - Damages to infrastructure and buildings
    - Pori / Malmö 20-25 M€, Copenhagen 745 M€, Bangkok 270M€
- Main factors for urban flooding
  - Increasing heavy precipitation
  - Inappropriate land-use
  - expansion of urban areas and soil sealing in areas with permeable soil
  - outdated drainage systems
CliPLivE Project

• Project CliPLivE – Climate-Proof Living Environment aimed to recognize geological and environmental risks on the coast of the Gulf of Finland
• Funded by South-East Finland – Russia ENPI CBC 2007 – 2013
• Partners
  • Geological Survey of Finland GTK
  • Regional Council of Kymenlaakso
  • Regional Council of Uusimaa
  • Helsinki Region Environmental Services Authority HSY
  • State Geological Unitary Company SC Mineral
  • A.P. Karpinsky Russian Geological Research Institute VSEGEI
  • Committee for Nature Use, Environmental Protection and Ecological Safety of the city of St. Petersburg
• Urban floods were one of the hazards project CliPLivE studied
Mapping methodology for urban floods

- Combining data in raster format:
  - Quaternary deposit map – GTK 1 : 20 000 or 1 : 50 000
  - Soil sealing map – EEA 2009 (asphalted areas, roofs…)
  - Soil surface slope – National Land Survey of Finland LiDAR
- Data processed in ArcGIS
- Datasets classification: low hydraulic conductivity or area with high percentage of soil sealing gets a higher value
- Surface slope either heightens or lowers an area’s sensibility to urban flooding: On plain areas flood potential is high; on steep slopes low
- Qualitative assessment
Geological hazard mapping – urban floods

Soil type

Soil sealing

Slope

Urban flood potential
### Results – The effect of soil type

<table>
<thead>
<tr>
<th>Soil permeability / other character</th>
<th>Soil type</th>
<th>Number of urban floods</th>
<th>Percentage of urban floods</th>
<th>Distribution of soil permeability class in the city of Vantaa (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>Sand, gravel</td>
<td>3</td>
<td>7.7</td>
<td>5.0</td>
</tr>
<tr>
<td>Good</td>
<td>Sandy till, coarse fine sand</td>
<td>4</td>
<td>10.3</td>
<td>17.0</td>
</tr>
<tr>
<td>Good</td>
<td>Man-made ground / geologically unmapped areas</td>
<td>10</td>
<td>25.6</td>
<td>9.4</td>
</tr>
<tr>
<td>Retaining</td>
<td>Fine sand, silt, fine-grained till</td>
<td>0</td>
<td>0</td>
<td>2.4</td>
</tr>
<tr>
<td>Retaining, organic</td>
<td>Peat, gyttja</td>
<td>0</td>
<td>0</td>
<td>4.5</td>
</tr>
<tr>
<td>Very retaining</td>
<td>Clay</td>
<td>21</td>
<td>53.9</td>
<td>43.1</td>
</tr>
<tr>
<td>Bedrock area</td>
<td>Bedrock outcrops and bedrock areas covered with less than 1 m thick soil layer</td>
<td>1</td>
<td>2.6</td>
<td>18.7</td>
</tr>
</tbody>
</table>


Source: Nuottimäki, K., Jarva, J. 2015.
Results – The effect of soil sealing

<table>
<thead>
<tr>
<th>Soil sealing percentage</th>
<th>Number of urban floods</th>
<th>Distribution of the recorded flood locations in different soil sealing percentages in the city of Vantaa</th>
<th>Distribution of soil sealing class in the city of Vantaa</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 29 %</td>
<td>5</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>30 – 49 %</td>
<td>1</td>
<td>2.6</td>
<td>10.2</td>
</tr>
<tr>
<td>50 – 79 %</td>
<td>15</td>
<td>38.5</td>
<td>13.0</td>
</tr>
<tr>
<td>80 – 99 %</td>
<td>14</td>
<td>35.9</td>
<td>6.9</td>
</tr>
<tr>
<td>100 %</td>
<td>4</td>
<td>10.3</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Source: Nuottimäki, K., Jarva, J. 2015.
Results – The effect of soil surface slope

<table>
<thead>
<tr>
<th>Slope class</th>
<th>Number of urban floods</th>
<th>Distribution of the recorded flood locations in different slope classes in the city of Vantaa</th>
<th>Distribution of slope class in the city of Vantaa</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 3 %</td>
<td>27</td>
<td>% 69.2</td>
<td>% 39.5</td>
</tr>
<tr>
<td>3 – 5 %</td>
<td>5</td>
<td>12.8</td>
<td>16.1</td>
</tr>
<tr>
<td>5 – 8 %</td>
<td>3</td>
<td>7.7</td>
<td>17.0</td>
</tr>
<tr>
<td>&gt; 8 %</td>
<td>4</td>
<td>10.3</td>
<td>27.3</td>
</tr>
</tbody>
</table>

Source: Nuottimäki, K., Jarva, J. 2015.
Urban flood risk mitigation

- The method developed in CliPLivE – project helps to assess suitable method for mitigating and managing local or regional urban flooding.

Infiltration possible →
Sealing not recommended

Comprehensive solution for the area

Surface structures such as open ponds should be favoured, infiltration not possible
Soil infiltration capacity
Risk = hazard + vulnerability
Urban flood risk
Cooperation with stakeholders and decision makers

- Sharing information – in meetings and in the field
- Expert and layman communication
- Science-stakeholder communication

=> Informed decision making
Application potential

Comparing the infiltration capacity and sites with construction rights
Urban flood risk mitigation - summary

- It is possible to identify current and potentially future areas prone to urban floods with the support of geology.
- Conditions that favour flooding are influenced by land use practices.
- Conditions leading to floods can be mitigated with the support of geology:
  - Underlying geology
  - Geomorphology
  - Quality and quantity of soil sealing
- The methodology provides support to identify urban flood mitigation options - also before the land is developed – locally and regionally.
- Urban flood occurrences can be mitigated by good land use practices and by taking local and regional natural qualities into account.
- Good land use practices help in mitigating adverse effects from urban floods to cities around the Baltic Sea and to its environment.
Thank you!
Philipp Schmidt-Thomé

More information on the subject:

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CliPLivE – project:
www.infoeco.ru/cliplive

Article:
Nuottimäki, K., Jarva, J. 2015: A qualitative approach for identifying areas prone to urban floods with the support of LiDAR. GFF. 15p. 16.10.2015.
http://dx.doi.org/10.1080/11035897.2015.1055512