Case study of flood damage assessment of YIZHUANG Beijing

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2013.9
Part 1. Introduction

What happened in recent years in Beijing?

- Urban local flooding has become the major disaster in a big city
Part 2. Methodology

➢ Classification of flood damage

- Tangible damage
  - Indirect losses
  - Direct losses

- Intangible damage
Part 2. Methodology

How to assess the flood damage?

- Remote Sensing Analysis
- Site Survey
- Hydraulic Model
- Socio-economic Survey
- Socio-economic Statistic
- Geospatial information

Hazard Indicator (Intensity, Frequency, Scope)

Exposure Assessment (Land use, Value, Distribution)

Loss Quantification (Value, Spatial Distribution)

\[ L = \sum_i \sum_j L_{ij} \sigma(i, j) \]
Part 3. Case study, Beijing Yizhuang

- Specific location of Yizhuang

- A newly developed town to the southeast of Beijing city central region, with the distance of 17.6km to the Tiananmen Square. The total area is 212.7km².
- As the high-tech industrial zone, is the region where great emphasis of flood damage assessment research should be placed.
Part 3. A case study of Beijing

- **Data required**
  - **What we used?**
    - ✓ Input data for drainage model;
    - ✓ Building data;
    - ✓ Hydraulic modelling result;
    - ✓ Building vulnerability information;
  - ✓ Basic data for hydraulic model;

![Regional pipe network](image1)

![DEM model](image2)

Elevation (m):
- 57.792 - 63.381
- 52.203 - 57.792
- 46.614 - 52.203
- 41.026 - 46.614
- 35.437 - 41.026
- 29.848 - 35.437
- 24.259 - 29.848
- 18.67 - 24.259
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- **Design rainfall**

\[ i = \frac{12.267 (1 + 0.913 \log P)}{(t + 13.4)^{0.725}} \text{ (mm/min)} \]

Storm intensity formula

- First step is to calculate the rainfall with different duration and specific return period. Then, the rainfall multiplied by the proportion to get each 5-minute rainfall.

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### 24h design rainfall pattern

<table>
<thead>
<tr>
<th>Times (min)</th>
<th>5</th>
<th>1010</th>
<th>1015</th>
<th>1020</th>
<th>1025</th>
<th>1030</th>
<th>1035</th>
<th>...</th>
<th>1440</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of H5</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion of (H15-H5)</td>
<td>46.67%</td>
<td>53.33%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Proportion of (H30-H15)</td>
<td>39.69%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion of (H45-H30)</td>
<td></td>
<td>34.55%</td>
<td>25.76%</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

- Design rainfall with 24h duration
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- Hydraulic modelling results

We adopted the DHI MIKE URBAN software, which couples the 1D drainage network model and the 2D overland flow model to simulate the inundation circumstances for different return periods.
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- **Building vector data**
  - Unique index value is introduced to distinguish building vector data, which could be overlapped with land use maps to generate building land use spatial distribution

- **We can get what the building is used for**
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Building vulnerability data

- We applied 10 depth-absolute damage curves to describe the vulnerability of different land use types.
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**Damage results**

✓ We developed a flood damage assessment tool using Python scripts and the Geo-processing functions within the ESRI ArcGIS software, to evaluate the damage directly from the hydraulic modelling results.

![Diagram showing the process of damage assessment](image)
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- This tool is capable of exerting flood damage calculation and risk analysis with spatial properties at single building scale
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- The flood damage statistics is summarised.

<table>
<thead>
<tr>
<th>Return period (year)</th>
<th>10</th>
<th>20</th>
<th>50</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall (mm)</td>
<td>172</td>
<td>197</td>
<td>229</td>
<td>254</td>
</tr>
<tr>
<td>Total Loss (million RMB)</td>
<td>201</td>
<td>323</td>
<td>497</td>
<td>590</td>
</tr>
</tbody>
</table>

Relationship of flood damage versus design storm frequency
Part 4. Conclusion

Based on hazard analysis, exposure analysis and vulnerability analysis of urban pluvial flooding, we demonstrated the approach of building content damage assessment methodology. Through case study of Yizhuang, we explained the required input data, which mainly includes basic input and simulation results of hydraulic modelling, building data and vulnerability information. We developed a GIS-based damage assessment tool that integrates all the above elements and achieves the economic loss quantification.
Thank you!