Verification of flood damage modelling using insurance data

Qianqian Zhou¹; Toke E. P. Petersen²; Bo J. Thorsen²; Karsten Arnbjerg-Nielsen¹

¹ Technical University of Denmark
² University of Copenhagen
Climate change and Insured costs

Copenhagen Floods:

- August 2010
- July 2011
- August 2011
State-of-the-art modelling approach

Inundation modelling

Vulnerability assessment

Damage estimation

Measurement & Monitoring

Calibration

Measurement

Data

Verification
Insurance data as a means

**Field Data:**
- Temporal scale
- Spatial scale

**Analysis tool:**
- Damage identification
- Damage assessment

Insurance industries

Research scholars
Objectives & Main questions

To what extent:

- is it possible to model the *damage per claim* given information about the *rainfall*?
- is it possible to model the *cost per day* given information about the *rainfall*?
- can simple *indicators* of flood risk give reliable information about the *flood risk*?
- can the insurance data be used to *verify* the hazard and flood risk maps in terms of *frequency and severity* of damages?
Case study

Area:
Aarhus: rainfall & damage
Risskov: hazard & Vulnerability modelling

Insurance data:
>1000 insurance claims
Geocoded
Year 2005-2011

Rainfall data:
Maximum hour intensity
Daily rainfall depth
Annual variation_month
Year 2005-2011
Correlation between claimed damage & rainfall characteristics

\[
\sqrt{D} = \mu + a \cdot d + b \cdot x + c \cdot \text{Month} + \varepsilon
\]

\(X\): hour precipitation intensity
\(d\): rainfall depth per day
\(Month\): annual variations described by a factor variable for each month

<table>
<thead>
<tr>
<th>Daily depth, (d)</th>
<th>Max hour intensity, (x)</th>
<th>Annual variation, (Month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per claim</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per day</td>
<td>***</td>
<td>**</td>
</tr>
</tbody>
</table>

† significant at 10%, * significant at 5 %, ** significant at 1%, *** significant at 0.1%
Correlation between claimed damage & rainfall characteristics

- Cost per claim
Correlation between claimed damage & rainfall characteristics

- Cost per day
Flood hazard modelling

- Simple GIS toolboxes used in the insurance industry
  - To identify flood zones or assess risk of flood
  - Based on simple risk indicators, e.g. topography and slope
  - Digital Elevation Models as inputs
  - Wetness index calculations and local depression identifications

- 1D-2D coupled inundation models
  - Input rainfall
  - Topographical characteristics
  - Drainage systems
Flood hazard modelling

Map by 1D-2D modelling

Wetness index map

Local depression map

Combined overview
Verification of damage assessment
### Verification of damage assessment

<table>
<thead>
<tr>
<th>Probability</th>
<th>Expensive &gt;25,000 DKK</th>
<th>Cheap 0-25,000 DKK</th>
<th>No cost 0 DKK</th>
<th>Flooded percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Often ≥ 0.1</td>
<td>3</td>
<td>11</td>
<td>11</td>
<td>56%</td>
</tr>
<tr>
<td>Sometimes 0.1-0.01</td>
<td>12</td>
<td>7</td>
<td>46</td>
<td>29%</td>
</tr>
<tr>
<td>Very unlikely &lt;0.01</td>
<td>8</td>
<td>8</td>
<td>1468</td>
<td>1%</td>
</tr>
</tbody>
</table>

**Location of damage:**

good statistical agreement for the high hazard events

**Costing of damage:**

results were less clear and damage costs are lower than expected. Possible reasons, e.g., individual protection measures
Conclusions

- Simple rainfall statistics are not able to describe the variation in cost per claim; however, prove feasible for the overall daily claimed costs.

- Simple GIS-operations are not helpful in giving reliable information on flood hazards.

- Insurance data are valuable for calibrating inundation modelling, although it’s difficult to accurately identify the flood location for the low hazard category.

- Take into account socioeconomic variables for better explanation of costing of damage per claim.

- Improvements on data collection and analysis are required.
Thanks for your attention!