Does the perception of extremity change?

An ongoing case study in the Sure river basin

Outline

• Introduction

• Methodology
  - Models, maps, flood hazard and vulnerability assessment

• Preliminary results
  - Maps, flood hazard, security deficit

• Conclusion

• Perspectives
Introduction

• Why this study?
  - Recent floods in Luxembourg
  - Is there a shift in flood frequency?

• A shift might be explained by:
  - Climate change
  - Land Use change
  - Change in river morphology
Observed changes

• Climate change (Saar-Lor-Lux region)
  - Increase of winter rainfall in last 50 years
  - Increase of westerly fluxes bringing storm fronts
  - From 19th to 20th century clear trend towards long lasting and intense westerly rainfall events

• Land Use change (Sure basin)
  - Increase of urban area
  - Increase of drained agricultural lands
  - No observed change in forest area

• Changes in river bed (Alzette basin)
  - 55% loss of floodplain in last 200 years
However

- Effects of climate change are strongly influenced by topography

- Effects of urbanisation only strong in headwaters

- Interaction between the effects make it difficult to predict changes in flood frequency
Study area

Stretch of the Sure river at Steinheim (Luxembourg)
Methodology

outline

• Use of hydro-climatological data sets as input for models
  - Peak discharges from 1870-1920 (Steinheim)
  - Daily rainfall from 1966-1996 (Sure basin)
  - Hourly rainfall (Sure basin) + discharge (Steinheim) 1996-2003

• Calculation of flood maps
  - Flood frequency
  - Flood hazard

• Assessment of urbanisation & security deficit
Methodology modelling

1. Rainfall runoff model (HBV)
   - Calibration with hourly 1996-2003 discharge data

2. Rainfall data
   - 1966-1996 daily rainfall as input

3. Two peak discharge data series:
   - 1870-1920
   - 1966-2003

4. Hydraulic model (HEC-RAS)
   - Calculation of flood extension maps

<table>
<thead>
<tr>
<th>Date</th>
<th>Discharge1</th>
<th>Date</th>
<th>Discharge2</th>
<th>Discharge3</th>
</tr>
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<tbody>
<tr>
<td>19/01/1873</td>
<td>870</td>
<td>13/12/1966</td>
<td>718</td>
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<tr>
<td>28/01/1877</td>
<td>514</td>
<td>21/02/1977</td>
<td>565</td>
<td></td>
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<tr>
<td>22/11/1878</td>
<td>510</td>
<td>04/02/1980</td>
<td>483</td>
<td></td>
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<td>27/12/1879</td>
<td>582</td>
<td>06/01/1982</td>
<td>454</td>
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<td>749</td>
<td>27/05/1983</td>
<td>495</td>
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<td>07/02/1984</td>
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<td></td>
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<td>27/11/1882</td>
<td>521</td>
<td>03/02/1988</td>
<td>464</td>
<td></td>
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<tr>
<td>04/11/1883</td>
<td>760</td>
<td>04/01/1991</td>
<td>461</td>
<td></td>
</tr>
</tbody>
</table>
According to a Swiss methodology (developed by OFEE, 1997), a flood hazard should be expressed in terms of flood intensity. The flood depth [m] and the flood velocity [m/s] have to be considered to assess the flood intensity of a given flood event.

<table>
<thead>
<tr>
<th>Flood intensity</th>
<th>Level</th>
<th>If V &lt; 1 m/s</th>
<th>If V &gt; 1 m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong</td>
<td>3</td>
<td>2.0 m &lt; H</td>
<td>2.0 m²/s &lt; HxV</td>
</tr>
<tr>
<td>Medium</td>
<td>2</td>
<td>0.5 m &lt; H &lt; 2.0 m</td>
<td>0.5 m²/s &gt; HxV &lt; 2.0 m²/s</td>
</tr>
<tr>
<td>Weak</td>
<td>1</td>
<td>0.0 m &lt; H &lt; 0.5 m</td>
<td>0.0 m²/s &lt; HxV &lt; 0.5 m²/s</td>
</tr>
</tbody>
</table>
Methodology
calculation of flood hazard

- By comparing flood intensity maps with the return period of peak discharges the flood hazard can be assessed

![Flood Hazard Diagram]

- Strong intensity:
  - 30 years: 3
  - 100 years: 3
  - 300 years: 3
  - Extreme: Hazard level: high

- Medium intensity:
  - 30 years: 2
  - 100 years: 2
  - 300 years: 1
  - Extreme: Hazard level: medium

- Low intensity:
  - 30 years: 2
  - 100 years: 1
  - 300 years: 1
  - Extreme: Hazard level: low

- Residual hazard:
  - 300 years extreme: Hazard level: low
Preliminary results
flood frequency maps

1870-1920

1966-2003
Preliminary results
flood frequency maps
frequency change
Preliminary results
flood hazard maps

1870-1920

1966-2003
Preliminary results
urbanisation of Steinheim

From 1775 to 2002
the urbanised area increased almost six fold
Preliminary results
security deficit maps

1870-1920

1966-2003

Steinheim at 1910

Steinheim at 2002

Affected buildings 92 %

Affected buildings 85 %
Preliminary results

Affected buildings

Decrease of percentage of affected buildings till 1993

Increase of vulnerability
Conclusion

• Change of flood frequency:
  - Less medium floods
  - Slight increase of major floods

• No major change in flood hazard

• Decrease of percentage of affected buildings

• Increase of total vulnerable area
Perspectives

• Difficult to assess a change in flood frequency with respect to climate-, land use- and river morphology change

• Perception has changed
  - From small village (nobody cared) to large village (more people involved)
  - Change from flood awareness to no flood awareness to flood awareness
Questions