Dynamic flood risk assessment using globally available data: an African example

Brenden Jongman & Philip Ward
Flooding in Africa: what are the impacts?
“[...] Globally, we need to better understand how and where we are vulnerable to disasters, and how best to manage the risks we face”

Robert B. Zoellick
President
The World Bank Group
June 2012
Global flood risk research at IVM & Deltares

- **IVM VU**
  - Multidisciplinary risk studies
  - ENHANCE project

- **Deltares**
  - Global hydrological modeling
  - Collaborative research with The Netherlands Environmental Assessment Agency
Flood risk: definition

RISK

- Exposure: the location of people or economic assets in hazard-prone areas
- Hazard: hazardous phenomena such as flooding
- Vulnerability: susceptibility (of exposed units) to suffer damage or loss
Flood risk: definition

- **Exposure**: the location of people or economic assets in hazard-prone areas
- **Hazard**: hazardous phenomena such as flooding
- **Vulnerability**: susceptibility (of exposed units) to suffer damage or loss

RISK = Exposure × Hazard × Vulnerability
Direct economic damages

Land use / Assets

Exposure

Inundation depth

Hazard

Vulnerability

Flood Damage

WATER DEPTH (m)

0 1 2 3 4 5

0 0.2 0.4 0.6 0.8 1

DAMAGE FACTOR

Netherlands Later curves (DM3)
- Urban
- Recreation
- Commercial
- Harbor
- Nature/Forest
- Arable land
- Grassland
- Greenhouses
- Zero grazing
- Infrastructure
- Construction

IVM Institute for Environmental Studies
Global flood hazard model

- Global hydrological inundation model

- **Currently:** up to 1 in 30 year floods
- **Possible:** up to 1 in 100 year floods

- **Output:**
  - Inundation extent (1km x 1km)
  - Inundation depth (10cm intervals)
Hazard validation: case-study Mozambique

Satellite observations

Global flood model
Flood risk assessment: case-study Mozambique

- Flood risk assessment using global data

- **Exposure:** three land-use types
  - Urban (density 0 – 100%)
  - Crops (density 0 – 100%)
  - Infrastructure (roads and railways)

- **Hazard:** global inundation model

- **Vulnerability:** vulnerability functions with depth
## Flood risk assessment: Mozambique case-study

<table>
<thead>
<tr>
<th>Damages to...</th>
<th>Model estimates, total Mozambique (millions)</th>
<th>Observed, year 2000 flood (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban areas</td>
<td>$3,162</td>
<td>$1,105</td>
</tr>
<tr>
<td>Crops</td>
<td>$17</td>
<td>$85</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>$131</td>
<td>$100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$3,310</strong></td>
<td><strong>$1,290</strong></td>
</tr>
</tbody>
</table>
Population impact

- **Affected population**
  - Number of people affected
  - Average poverty, age break-down and health of affected people

- **Mortality**
  - Expected deaths
    - Flood depth
    - Poverty and health
    - Governance indicators

*Source: Jonkman et al., 2008*
Dynamic scenarios

- **Flood risk under scenarios of..**
  - Climate change
  - Population growth
  - Urban expansion
  - Wealth growth

- **Dynamic assessment**
  - How does flood risk change?
  - Which developments matter?
  - Which can we influence?
Adaptation measures

- Model can be used to assess adaptation measures

1. **Hazard reduction**
   - Standard of flood protection

2. **Exposure reduction**
   - Value of assets in flood zone

3. **Vulnerability reduction**
   - Asset vulnerability
   - Societal resilience

(Source: Rijkswaterstaat)
Adaptation measures

- Model can be used to assess adaptation measures

![Graph showing expected damage with and without adaptation]

Source: De Moel et al., 2011
Global scale analyses

Total assets exposed to river flooding, 2010

Exposed assets (billions USD 2005 PPP)

- Asia
- Caribbean
- Latin America
- North America
- Sub Saharan Africa
Links to stakeholders operations

1. Quantifying and mapping **current and future flood risk**

2. Linking to **adaptation planning and financing**

3. Assessing the effects of **development** on flood risk

4. Applications in **short- to medium-term disaster planning**

5. Added value to the **Global Assessment Report**?
Thank you for your attention

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Indirect effects and macroeconomic impact

- Global Trade Analysis Project

- Direct damages cause changes in flows

- Effect on other countries
Population impact

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