Global Exposure Analysis on Floods/Drought and Poverty

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Drought and flood risk / exposure

Population living in 100 year floodplain, 1970-2050 (Jongman et al., 2012)

**Flood facts:**
- 220,000 fatalities (1980-2013)

Percentage change in occurrence of days with drought conditions, 2085 relative to present (Prudhomme et al., 2013)

**Drought facts:**
- $6-8 billion p.a.
- 11 million fatalities (1900-2008)
- 2 billion people affected (1900-2008)
What about poverty?

Flood exposure increase

Source: UNISDR Global Assessment Report 2011
Research questions

- Are poor more exposed to floods/droughts measured at the country scale?
- Do poor become more exposed to floods/drought in the future due to climate change?
- What are the implications for policy making?

Investigated for 52 countries with household survey data (DHS wealth index) and at sub-national scale for 2 countries and one city (Morocco, Malawi, Mumbai)
Methods

PCR-GLOBAL DynRout

EU-WATCH 1/100 yr Flooding map

EU-WATCH 1/100 yr Flooding & Wealth map

USAID’s DHS Wealth map - Colombia

EU-WATCH 1/100 yr Drought map

EU-WATCH 1/100 yr Drought & Wealth map

Hazard & Wealth statistics

Hazard map legend
- 299 Inundation depth (cm)
- 112 Relative drought intensity (LTM Q months)

Wealth map legend
- 1st Wealth quintile (lowest 20%)
- 2nd Wealth quintile
- 3rd Wealth quintile
- 4th Wealth quintile
- 5th Wealth quintile (highest 20%)
Methods cont’d

• How exposed are the poor ($f_p$) compared to average ($f$)

$$I_p = \frac{f_p}{f} - 1$$

• “Poor” is relative to the rest of the countries household wealth (lowest quintile)
• Poverty is measured with a “wealth index”
Methods cont’d

- Future:
  - How does the poverty exposure index change (floods/droughts)?
  - How does the average amount of affected people per year change?
Results: poverty exposure index and floods

Floods
Results: poverty exposure index and flooding

Poverty exposure index for 100 year return period flood

- **Red** indicates areas where poorest quintile of population has a relatively greater exposure to flooding (compared to other population quintiles)

- **Blue** areas where poorest quintile of population has a relatively lower exposure to flooding

- Hatched areas: variability due to household location uncertainty is large
Results: poverty exposure index and flooding

Poverty exposure index for 100 year return period flood: urban households only

- **Red** indicates areas where poorest quintile of population has a relatively greater exposure to flooding (compared to other population quintiles)

- **Blue** areas where poorest quintile of population has a relatively lower exposure to flooding
Results: poverty exposure index and drought

Droughts
Results: poverty exposure index and drought

Poverty exposure index for 100 year return period drought

- **Red** indicates areas where poorest quintile of population has a relatively greater exposure to drought (compared to other population quintiles)

- **Green** indicates areas where poorest quintile of population has a relatively lower exposure to drought

In many of these countries, poor are subsistence farmers

- **Hatched areas**: one of quintiles lower than 1% affected
Floods and droughts compared

- Patterns are fairly similar
- Meaning: where poor are disproportionally affected by floods, they are also disproportionally affected by dry conditions
- In S-E Asia, droughts hit poor more than floods
Poverty and floods at sub-national scale

- Examining exposure using sub-national poverty estimates
- Pinpoint areas where high poverty and flood exposure coincide

Sources: Morocco High Commission for Planning, World Bank Poverty Estimates, Baker et al. (2005), Hailegatte et al. (2010)
Morocco and Malawi

Morocco – high hazard and poverty in northwest

Legend
Modeled flood extent RP100
- Flood extent
Poverty headcount (%)
- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 52

Sources: Morocco High Commission for Planning, Deltalres/VU

Kenitra

Malawi – high hazard and poverty in south

Legend
Modeled flood extent RP100
- Flood extent
Poverty headcount
- 0.80 - 0.92
- 0.60 - 0.80
- 0.40 - 0.60
- 0.20 - 0.40
- no poverty estimate

Sources: World Bank, Deltalres/VU

Nsanje

January 2015 event
Source: UNOSAT, German Space Agency
### Household Income Distribution

<table>
<thead>
<tr>
<th>Income Range (Rs./month)</th>
<th>Share of Population in Survey (%)</th>
<th>Share of Population Exposed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5000</td>
<td>24%</td>
<td>41%</td>
</tr>
<tr>
<td>5001–7500</td>
<td>28%</td>
<td>34%</td>
</tr>
<tr>
<td>7501–10000</td>
<td>23%</td>
<td>19%</td>
</tr>
<tr>
<td>10001–15000</td>
<td>12%</td>
<td>5%</td>
</tr>
<tr>
<td>15001–20000</td>
<td>6%</td>
<td>1%</td>
</tr>
<tr>
<td>&gt;20000</td>
<td>6%</td>
<td>1%</td>
</tr>
</tbody>
</table>

**n=21,691**

**n=930**

### Legend

- **Modeled Historical Flood RP100**
  - Flood extent
- **Modeled Flood RP 100 with Climate Change**
  - Flood extent
- **Household Location by Income Category**
  - <5,000
  - 5,001-7,500
  - 7,501-10,000
  - 10,001-15,000
  - 15,001-20,000
  - >20,000
  - Mithi River
- **Ward Boundaries of Mumbai**

Source: Bokar et al. (2005), Mukkagatti et al. (2014), RMS for flood maps.
Climate change

Where are poor disproportionately affected by climate change?

Yamuna floodplain India.

Source:
Results: future changes [%] in population exposed to flooding

- Hatched areas: standard dev. of 5 GCM results > 50% of their mean
Where will climate change hit the poor more severe than average?

Where are poor experiencing disproportionately more flooding in the future?
- a) Bias in poor exposed (> 10%)
- b) Increase in exposure in 2050 > 10%

- **Grey** are countries that are part of this analysis
- **Hashed** are countries where poor are more vulnerable
Results: future changes [%] in population exposed to drought

...Results here are preliminary and are being reviewed for accuracy...
Conclusions

• Poor people are disproportionately affected by climate change induced increases in flood risk in Africa, countries above the equator
• In particular urban areas
• Same for droughts (but more Southern Africa, adding S-E Asia)
• More exposure bias at sub-national scale, areas which may be of policy priority
Further research

- Finalize the analysis for dry conditions
- Examine more countries sub-nationally with poverty maps
- Investigate the significance of the results further
Discussion points

- How do our results compare to findings in other hazard domains (natural, political, health)?
  - Similar patterns of bias in poor affected?

- How to make results across hazards intercomparable?

- How relate (quantify) findings to the flow into or out of poverty dependent on effect on
  - Consumption
  - Assets
  - Productivity
  - Opportunity

\[ y = \sum_{j \in J} \alpha \beta_j \]

Income = assets * productivity
Thank you!

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Background materials
• Veldkamp et al., in review. Changing mechanism of global water scarcity events: impacts of socioeconomic changes and inter-annual hydro-climatic variability.