Deltares
Enabling Delta Life

IVM Institute for Environmental Studies

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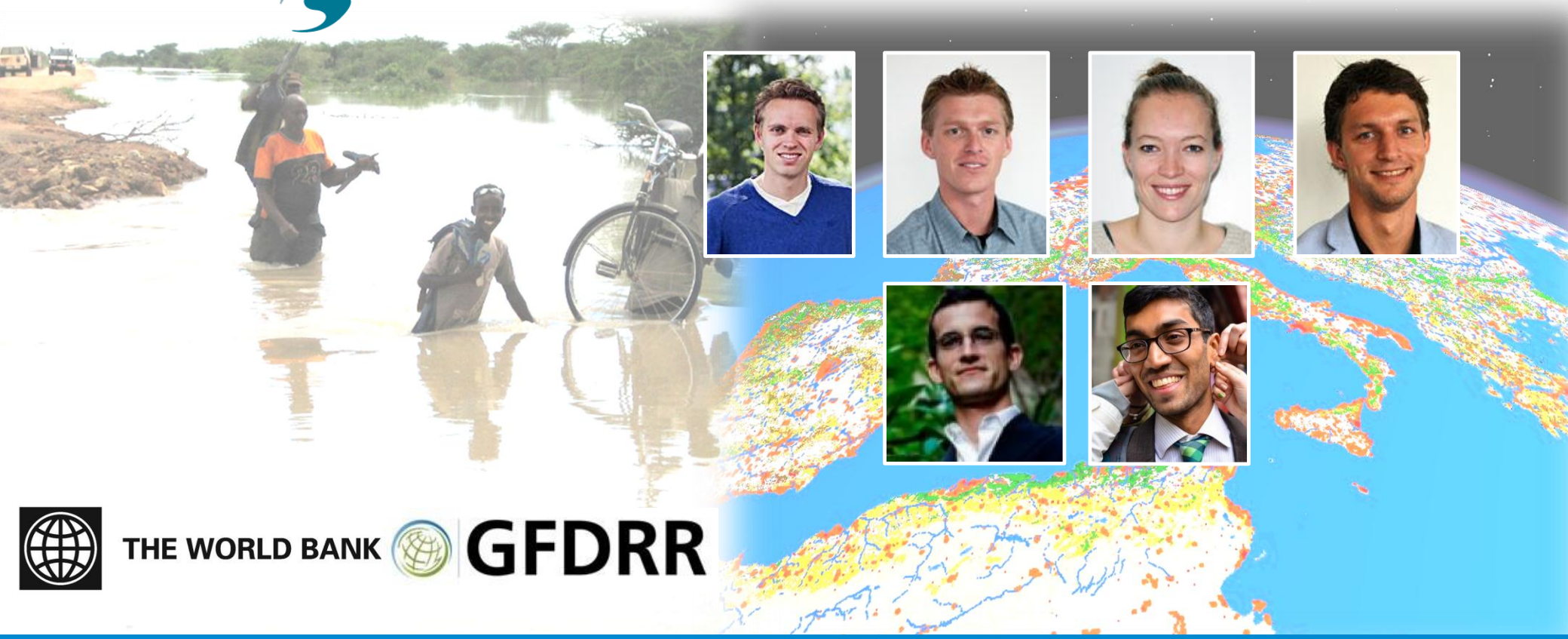


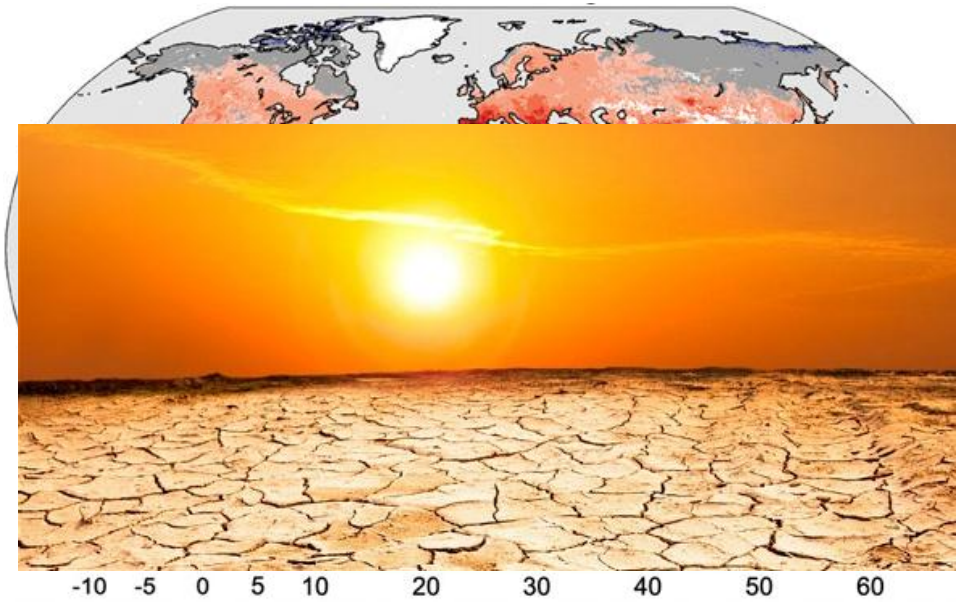
THE WORLD BANK GFDRR

Global Exposure Analysis on Floods/Drought and Poverty

Hessel Winsemius, Philip Ward, Ted Veldkamp, Brenden Jongman, Stephane Hallegatte, Mook Bangalore

Drought and flood risk / exposure

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



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

Flood facts:

$24 billion p.a. (2001-2011)

220,000 fatalities (1980-2013)

Drought facts:

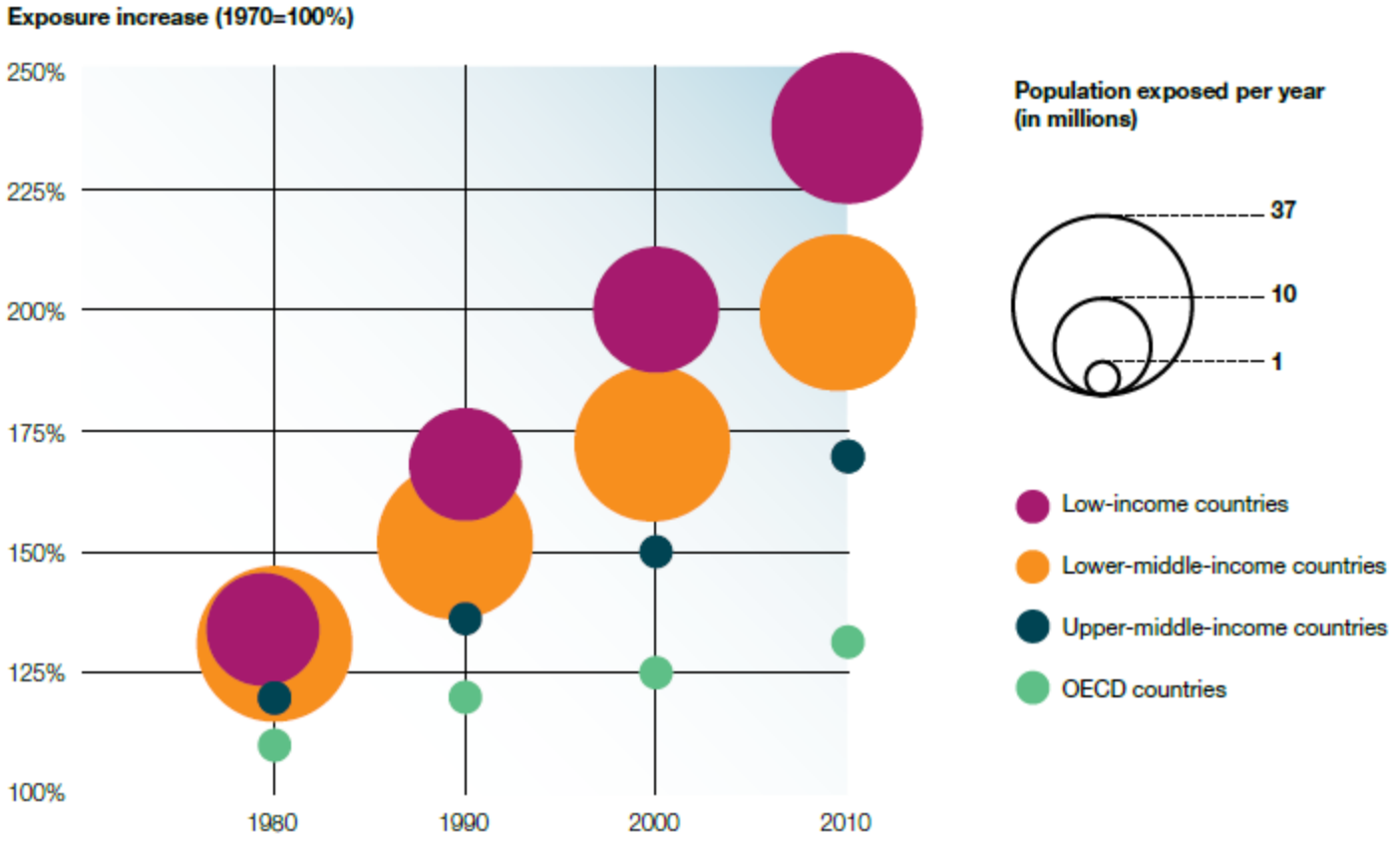
$6-8 billion p.a.

11 million fatalities (1900-2008)

2 billion people affected (1900-2008)

What about poverty?

Flood exposure increase



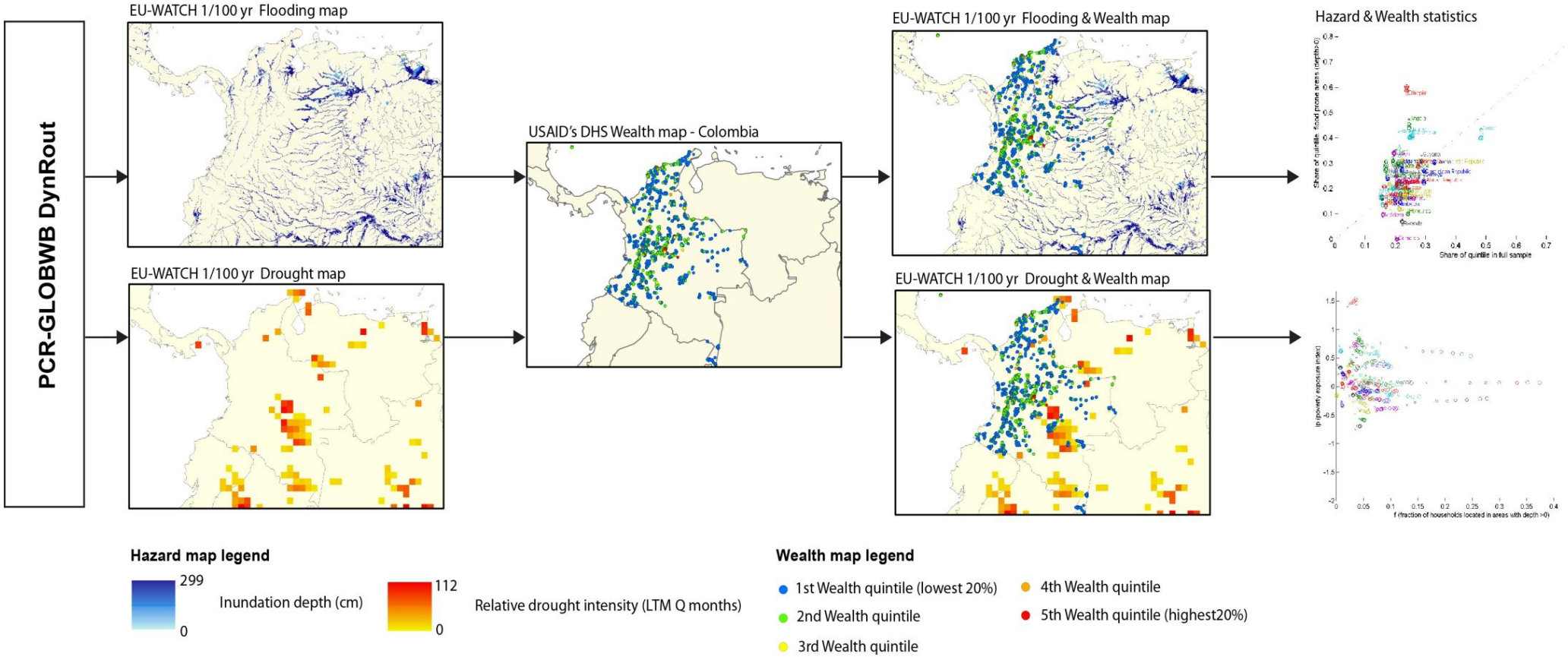
Source: UNISDR Global Assessment Report 2011

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-GLOBWB DynRout
EU-WATCH 1/100 yr Flooding map
EU-WATCH 1/100 yr Drought map
USAID's DHS Wealth map - Colombia
EU-WATCH 1/100 yr Flooding & Wealth map
EU-WATCH 1/100 yr Drought & Wealth map
Hazard & Wealth statistics
Hazard map legend
299
0
Inundation depth (cm)
112
0
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 (highest20%)

Methods cont'd

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

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

- "Poor" is relative to the rest of the countries household wealth (lowest quintile)
- Poverty is measured with a "wealth index"

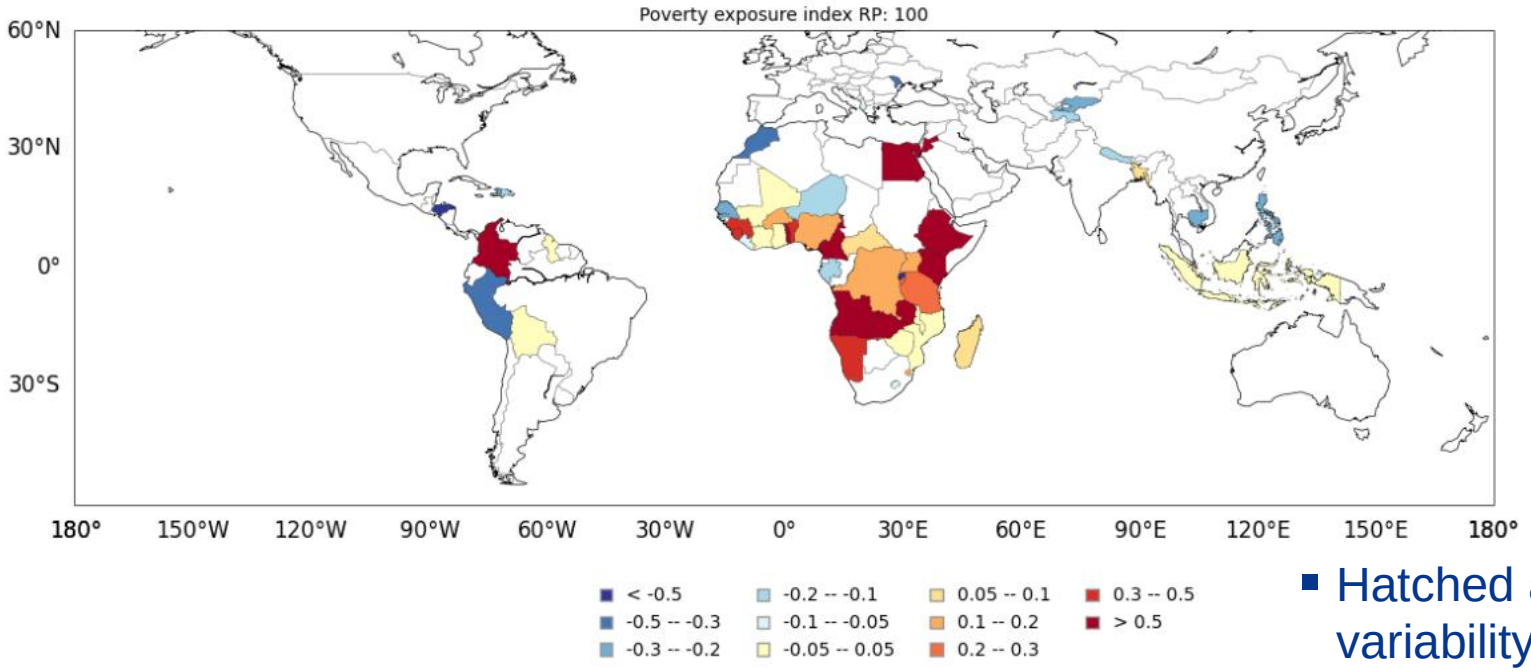
Methods cont’d

- 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



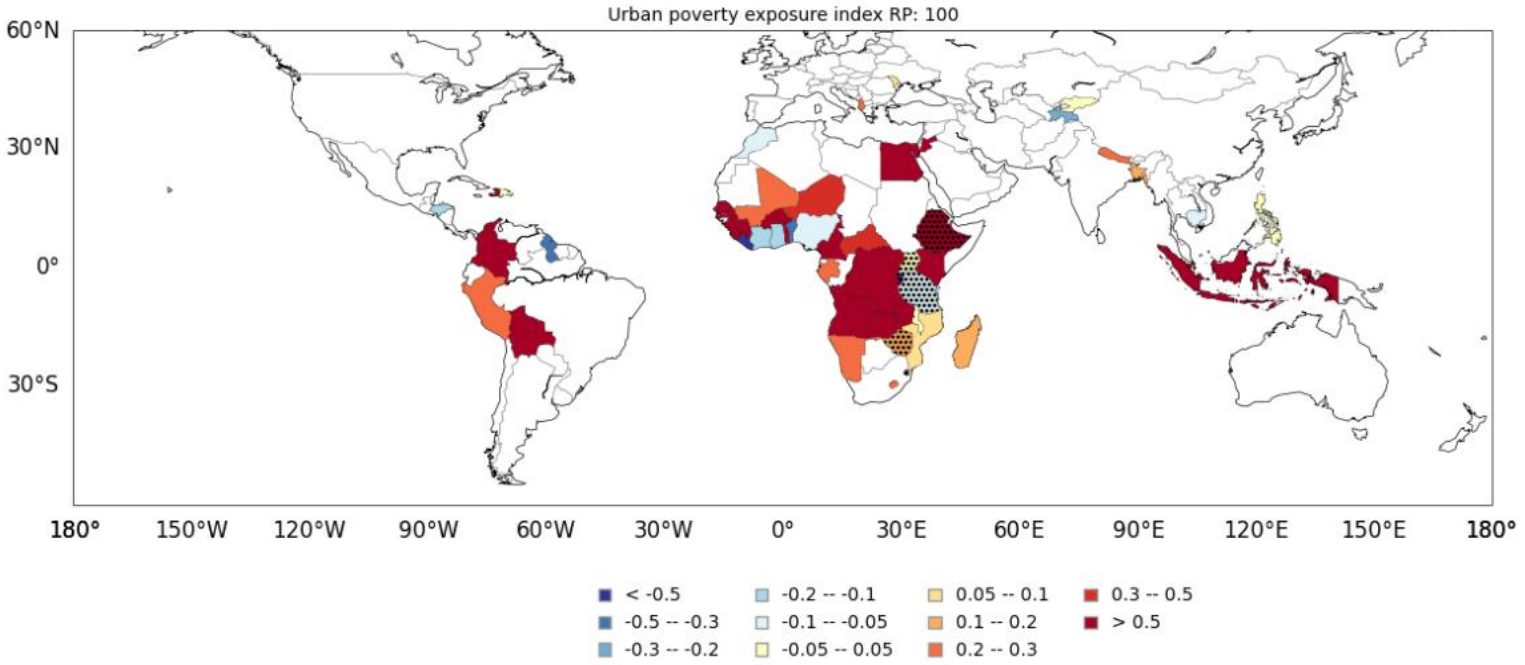
Poverty exposure index for 100 year return period flood

- Hatched areas: variability due to household location uncertainty is large

•**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 flooding



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

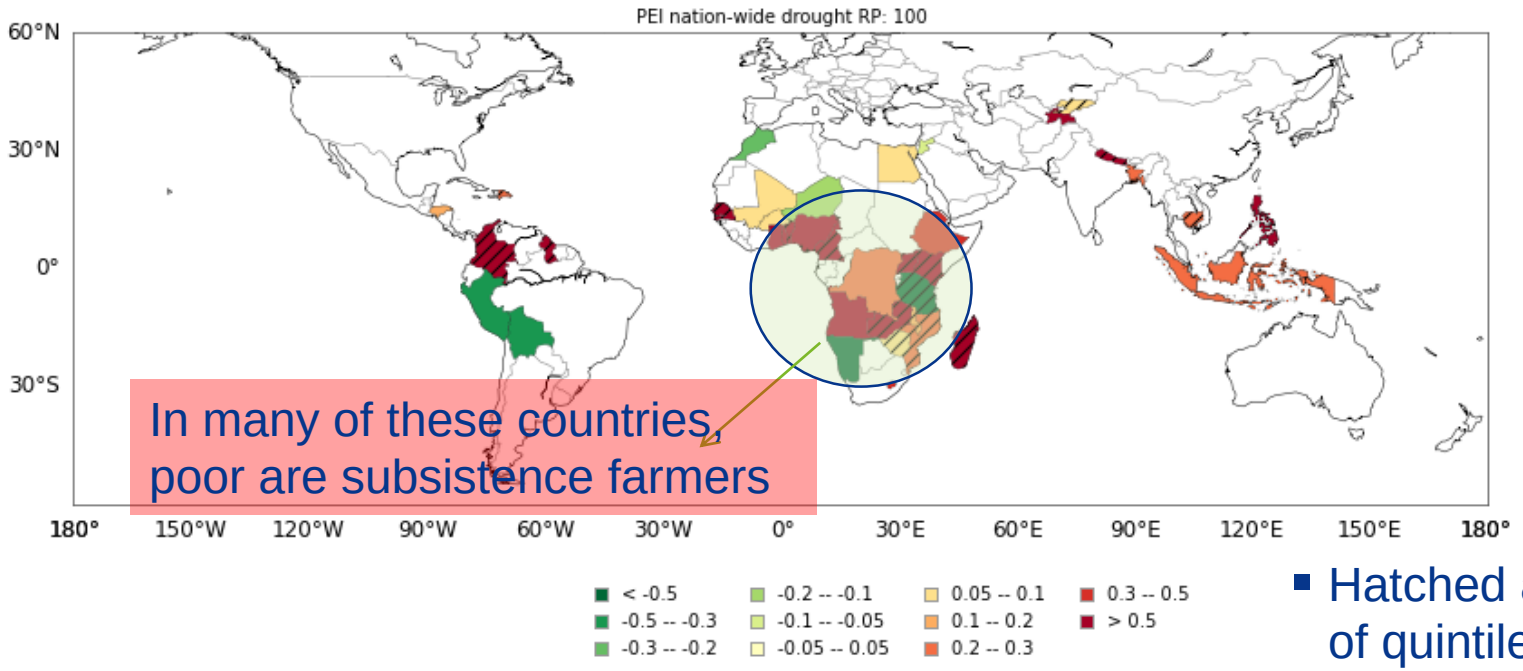
- **Red** indicates areas where poorest quintile of population has a relatively greater exposure to flooding (compared to other population quintiles)

- **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



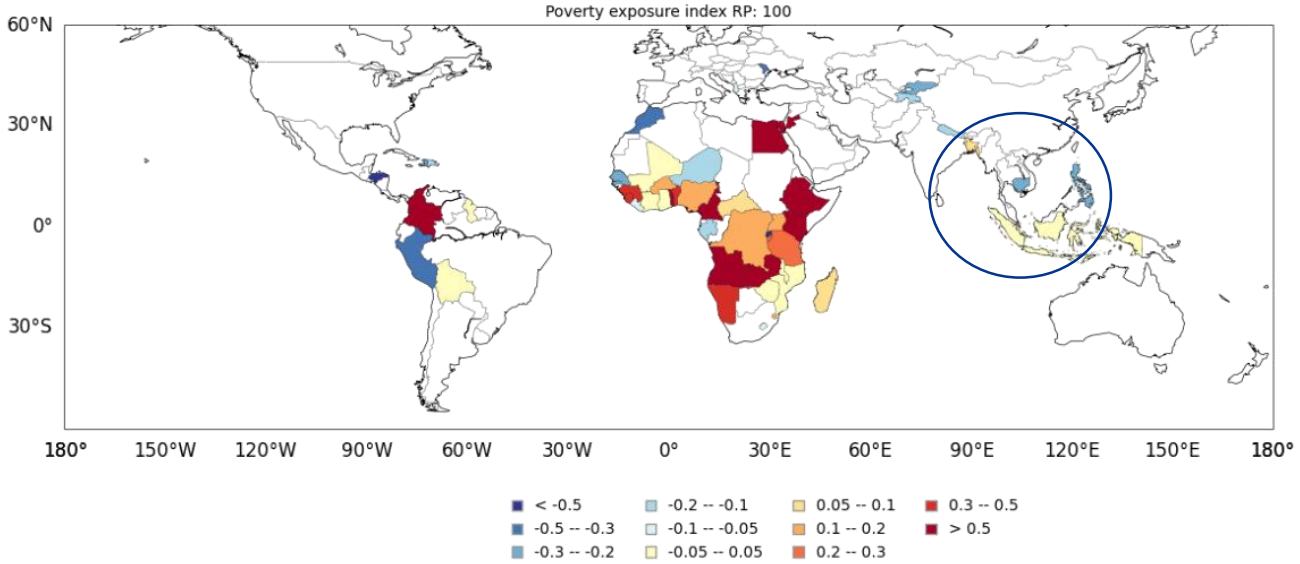
- Hatched areas: one of quintiles lower than 1% affected

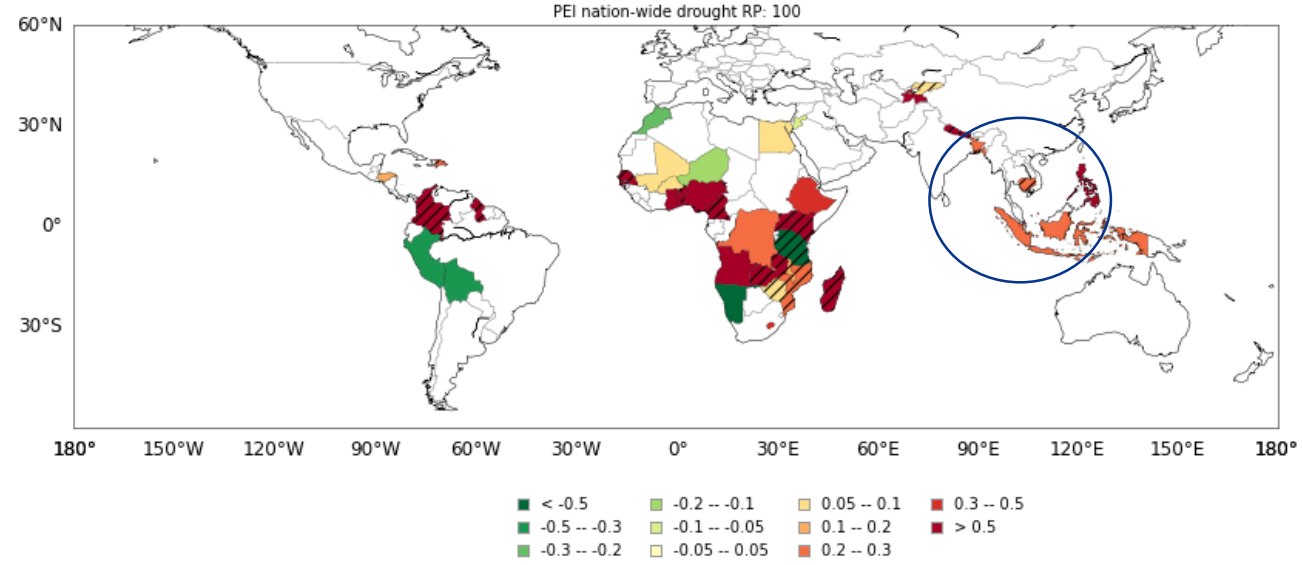
Poverty exposure index for 100 year return period drought

•**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

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

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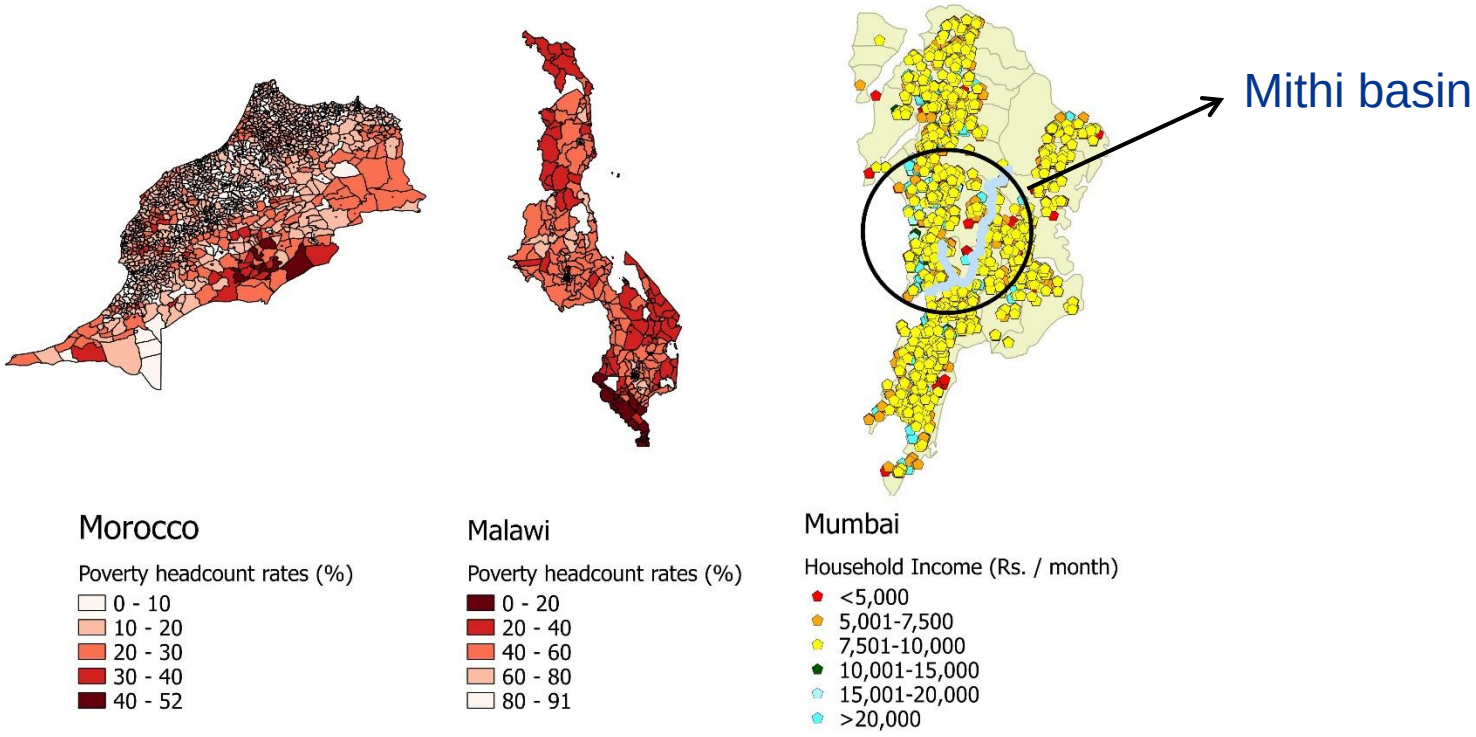
Poverty and floods at sub-national scale

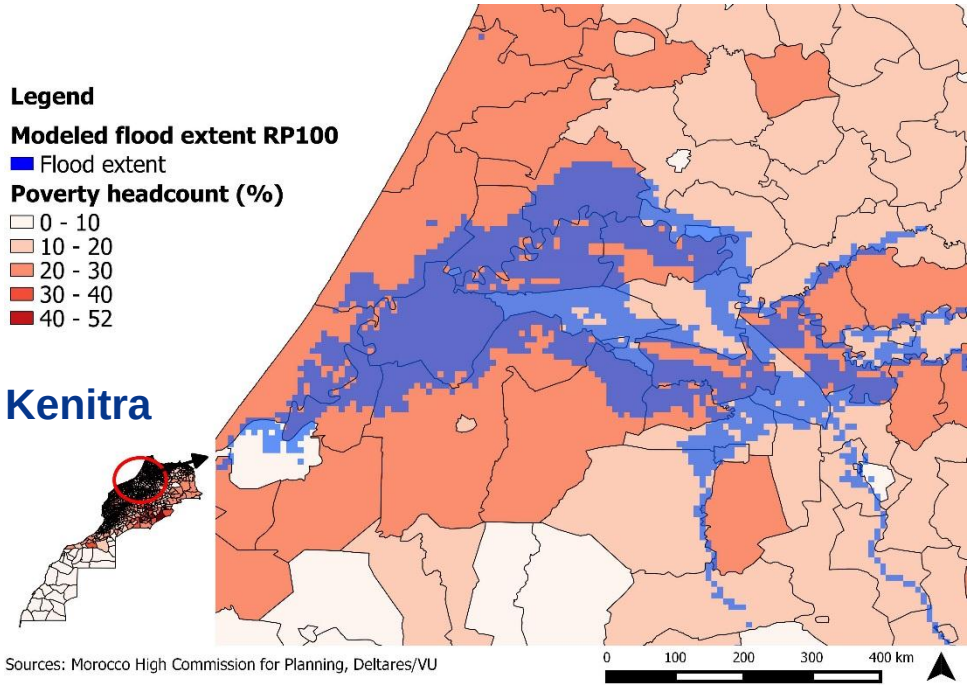
- Examining exposure using sub-national poverty estimates
- Pinpoint areas where high poverty and flood exposure coincide



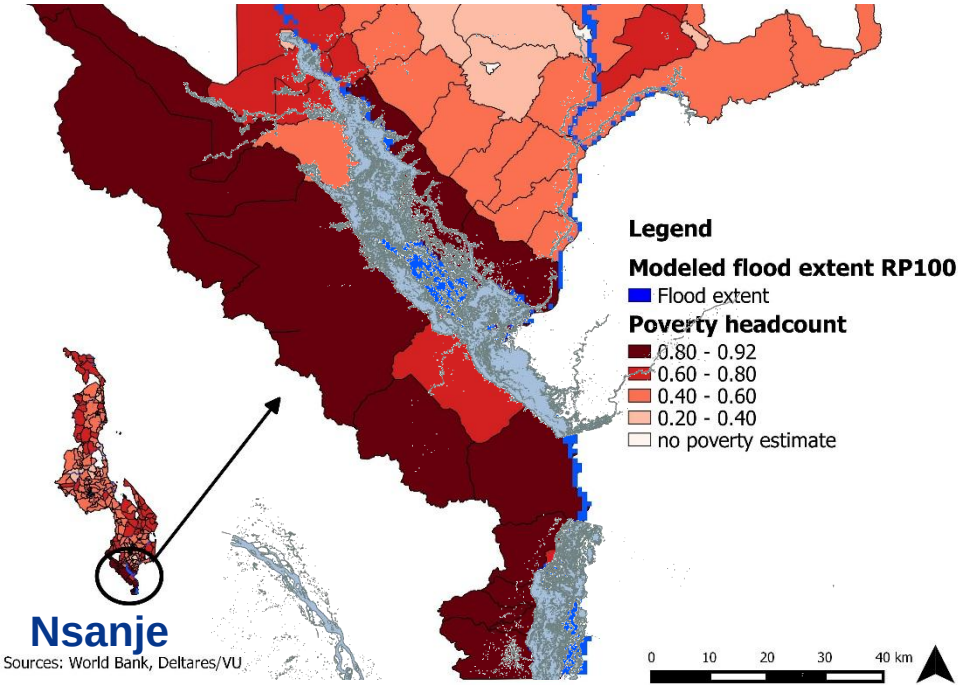
Sources: Morocco High Commission for Planning, World Bank Poverty Estimates, Baker et al. (2005), Hallegatte et al. (2010)

Morocco and Malawi

Morocco – high hazard and poverty in northwest



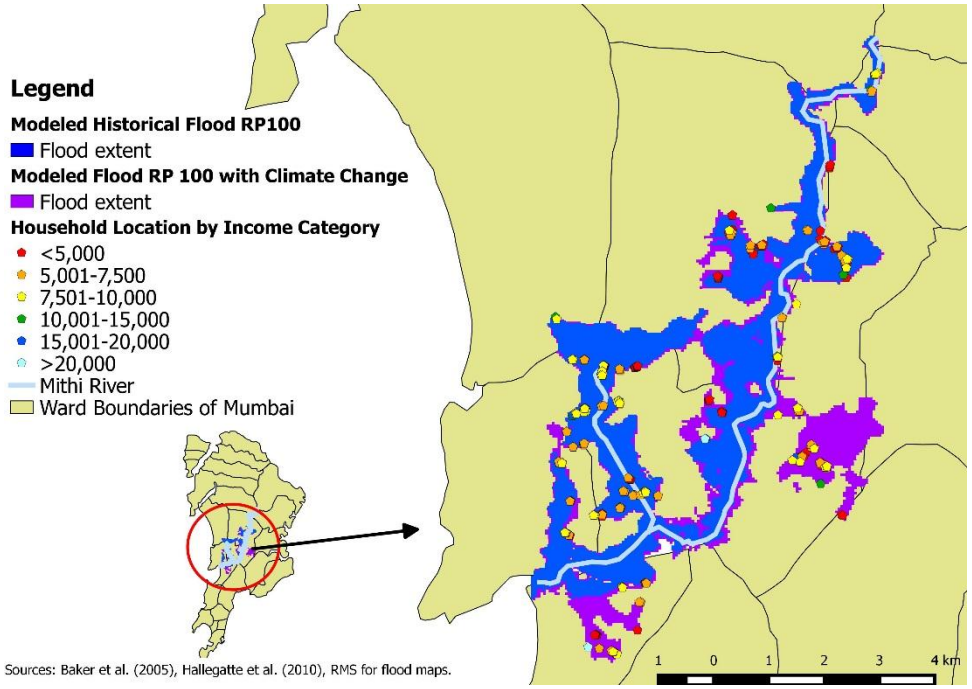
Malawi – high hazard and poverty in south



January 2015 event

Source: UNOSAT, German Space Agency

City-scale: Mumbai



Household income (Rs./month)	Share of population in survey (%)	Share of population exposed (%)
<5000	24%	41%
5001–7500	28%	34%
7501–10000	23%	19%
10001–15000	12%	5%
15001–20000	6%	1%
>20000	6%	1%
	n=21,691	**n=930**

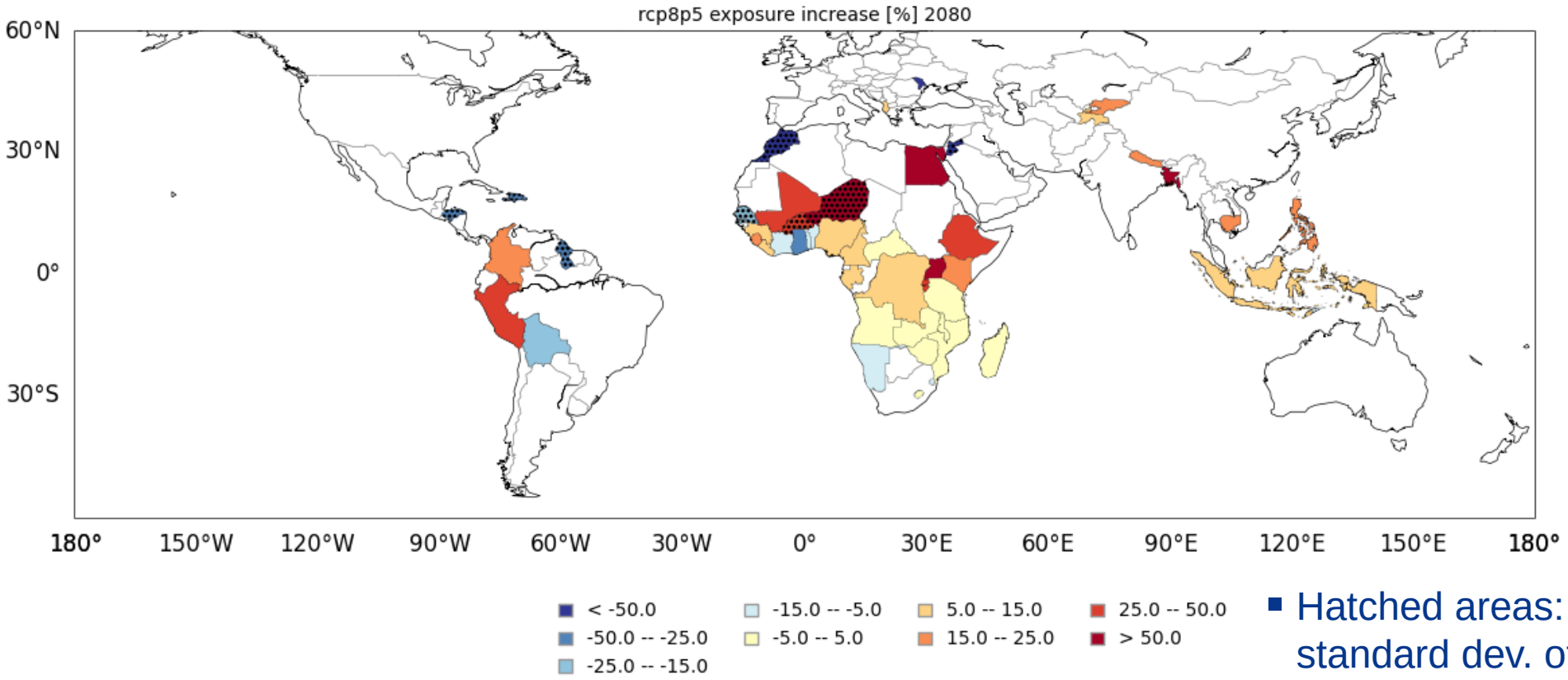
Climate change

Where are poor disproportionately affected by climate change?

Yamuna floodplain India.

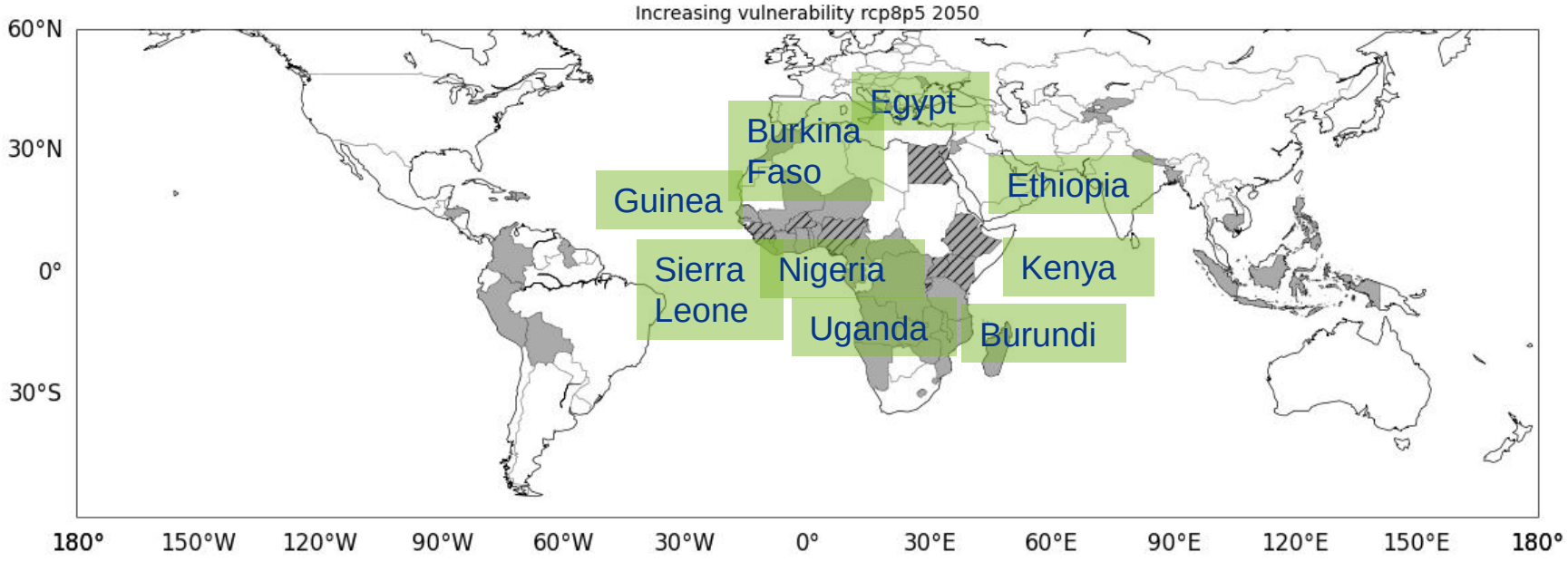
Source: http://www.thehindu.com/news/cities/Delhi/ddas-proposal-to-redraw-yamuna-floodplain-criticised/article5031574.ece

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



- Hatched areas: standard dev. of 5 GCM results > 50% of their mean

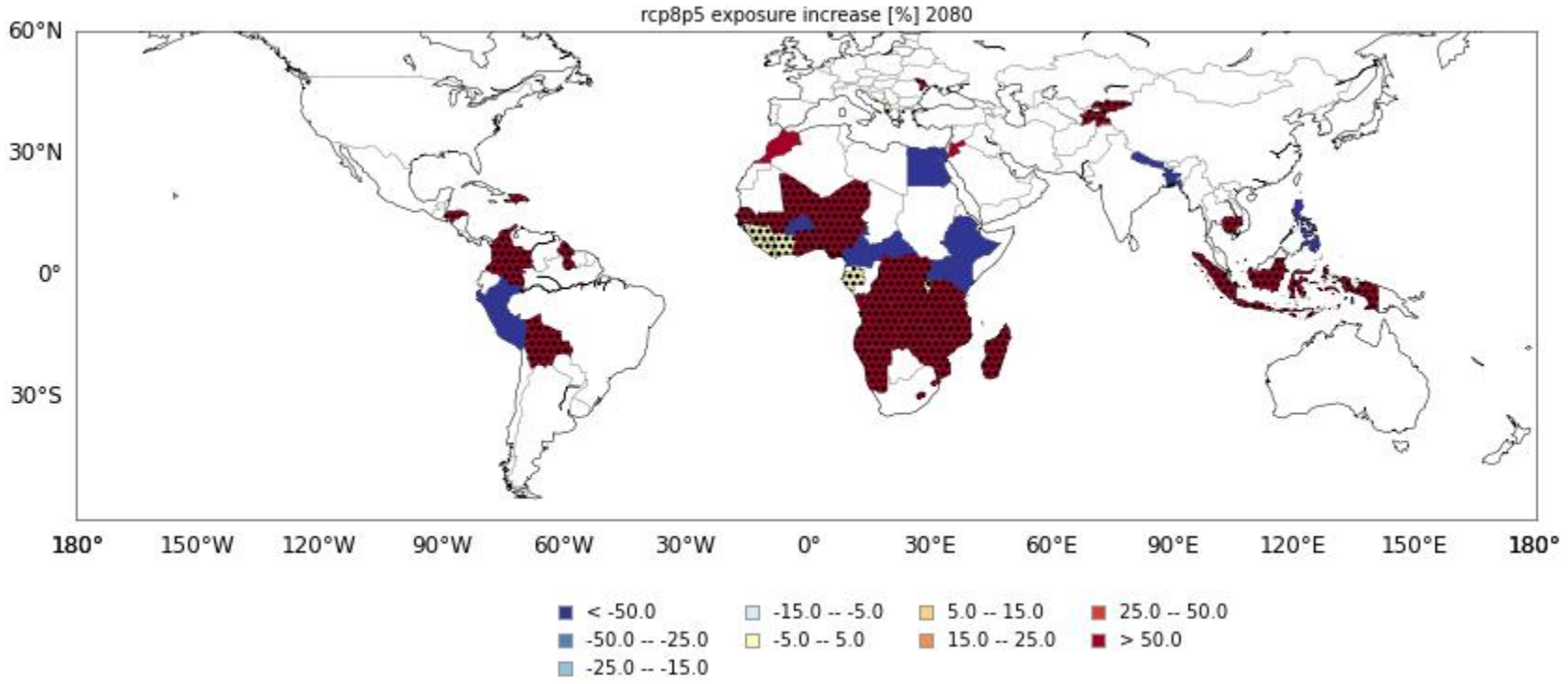
Where will climate change hit the poor more severe than average?



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

Income=assets * productivity

$$y = \sum_{j \in J} \alpha \beta_j$$

Thank you!

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Background materials

•Winsemius et al., 2013. A framework for global river flood assessment. *Hydrology and Earth System Sciences*, doi:10.5194/hess-17-1871-2013

•Ward et al., 2013. Assessing flood risk at the global scale: model setup, results, and sensitivity. *Environmental Research Letters* doi:10.1088/1748-9326/8/4/044019.

Jongman et al., 2012. Global exposure to river and coastal flooding: Long term trends and changes. *Global Environmental Change*, doi:10.1016/j.gloenvcha.2012.07.004.

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