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Flood damage modelling on a global scale: exposure and trends, 1970 – 2050

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Introduction

Over the period 1997 – 2009, global flooding events have amounted to an estimated 17 billion dollars in total damages per year (UNISDR, 2009). With climate change and population growth expected to contribute to even higher damages in the future, there is a rising demand for flood damage models on a global scale.

We present an estimation of global exposure to river flooding, using two different methods. Both methods are based on historical population and land-use data for the years 1970 – 2005, and are extrapolated to 2050 using population and economic forecasts.

Methods

Data

o Flood prone areas from Herold & Mouton (2011)
o Historical land-use and population data for 1970 – 2005 from HYDE database (Klein Goldewijk et al, 2010)
o Population and GDP data & forecasts from the World Bank

Land-use method

1. Urban area within flood zones calculated for each country
2. Damages per country calculated on the basis of GDP-normalised depth-damage functions, assuming maximum inundation levels
3. Extrapolated to 2050 using population growth, GDP projections and changes in relative urbanisation
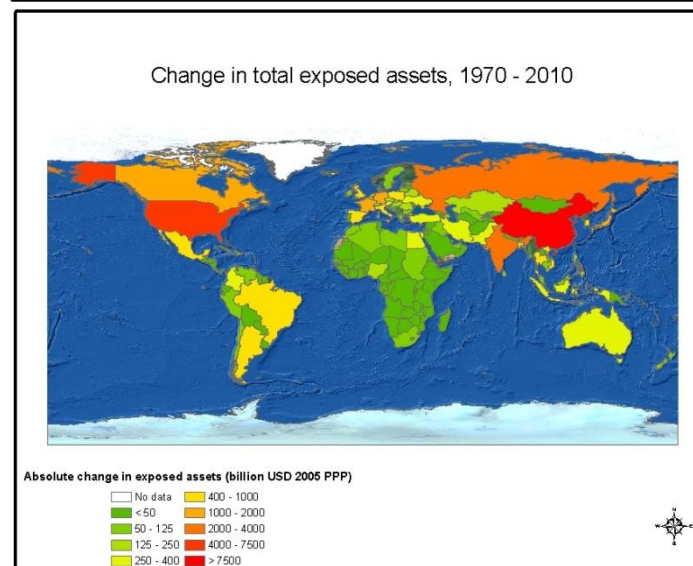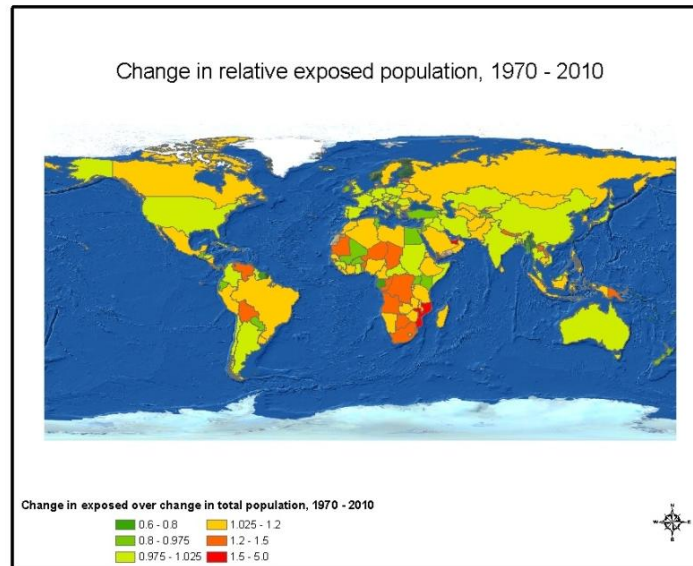
Population-based method

1. Population within flood zones calculated for each country
2. Total exposed assets (Nicholls et al, 2008):

$$E_a = E_p \times GDP_{percapita(PPP)} \times 5$$

3. Extrapolated to 2050 on the basis of population growth and GDP projections

References

Herold C. and F. Mouton, 2011. Hydrol. Earth Syst. Sci. Discuss., 8, 305–363.

Klein Goldewijk K., A. Beusen, G. van Drecht, and M. de Vos, 2010. Global Ecology and Biogeography, 20:73-86.

Nicholls R. J., S. Hanson, C. Herweijer et al., 2008. OECD Publishing, Paris, France,

UNISDR, 2009. Global assessment report on disaster risk reduction .

Change in relative exposed population, 1970 - 2010

Change in exposed over change in total population, 1970 - 2010
- 0.6 - 0.8
- 0.8 - 0.975
- 0.975 - 1.025
- 1.025 - 1.2
- 1.2 - 1.5
- 1.5 - 5.0

Change in total exposed assets, 1970 - 2010

Absolute change in exposed assets (billion USD 2005 PPP)
- No data
- < 50
- 50 - 125
- 125 - 250
- 250 - 400
- 400 - 1000
- 1000 - 2000
- 2000 - 4000
- 4000 - 7500
- > 7500

Results

Past and current exposure, 1970 - 2010

o Strong increase of exposed population and damage over time
o Highest total exposed population in China and India
o Highest per capita exposed assets (population based) and urban area (land-use based) in the US and Australia, respectively
o Visible impact of the recent financial crisis on the value of exposed assets
o Largest changes in relative exposed population between 1970 and 2010 in developing countries

Future exposure, 2010 - 2050

o Largest exposed population increase in India, Southeast Asia, and the United States
o Average exposed assets per capita remains highest in the US and Europe.
o Estimates of the total value of exposed assets per country vary between methods. On the basis of population, China and India outweigh all other countries in 2050. According to the land-use model, the value of total exposed assets is highest in the US

Conclusions

o Global exposure to river flooding is increasing in absolute and relative terms
o Past, current and future exposure can be estimated using population and land-use
o More research is needed for actual damage approximations on world level

Total flood exposure per capita - 2 methods

USD 2005 PPP
- Population method
- Land-use method

Exposed assets per head - population-based method

USD 2005 PPP (x1000)
- Asia
- Australia
- Caribbean
- Europe
- Latin America
- North America
- NorthAfrica
- Sub Saharan Africa

Knowledge for Climate