

## Assessing future extreme weather risk: current approaches and estimates

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Deltas in Times of Climate Change,  
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## Trends in disaster losses?

- Economic losses from weather disasters:
  - 1977-1986: 8.6 billion US\$ / year
  - 1997-2006: 45.1 billion US\$ / year
- Increase of 125% per decade
- GDP growth: 35-45% per decade

Source: Bouwer *et al.* 2007, *Science*

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## Trends in disaster losses?

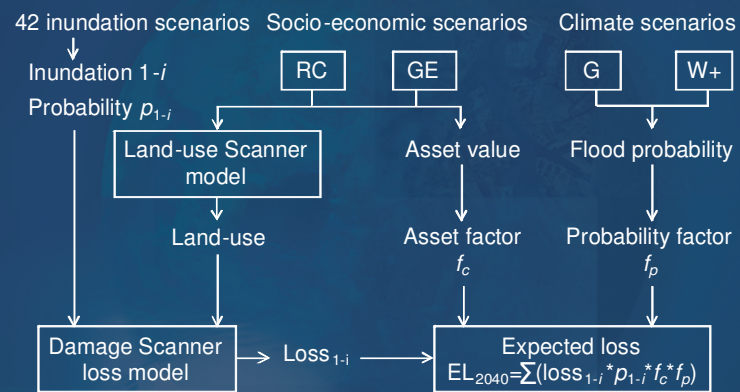
Hazard	Location	Period	Normalization	Normalized loss	Reference
Bushfire	Australia	1925-2009	Dwellings	No trend	Crompton et al. submitted
Earthquake	USA	1900-2005	Wealth, population	No trend	Vranes and Pielke 2009
Flood	USA	1926-2000	Wealth, population	No trend	Downton et al. 2005
Flood	China	1950-2001	GDP	Increase since 1987	Fengqing et al. 2005
Flood	Europe	1970-2006	Wealth, population	No trend	Barredo 2009
Flood	Korea	1971-2005	Population	Increase since 1971	Chang et al. 2009
Flood and landslide	Switzerland	1972-2007	None	No trend	Hilker et al. 2009
Hail	USA	1951-2006	Property, insurance market values	Increase since 1992	Changnon 2009a
Windstorm	USA	1952-2006	Property, insurance market values	Increase since 1952	Changnon 2009b
Windstorm	Europe	1970-2008	Wealth, population	No trend	Barredo 2010
Thunderstorm	USA	1949-1998	Insurance coverage, population	Increase since 1974	Changnon 2001
Tornado	USA	1890-1999	Wealth	No trend	Brooks and Doswell 2001
Tornado	USA	1900-2000	None	No trend	Boruff et al. 2003
Tropical storm	Latin America	1944-1999	Wealth, population	No trend	Pielke et al. 2003
Tropical storm	India	1977-1998	Income, population	No trend	Raghavan and Rajesh 2003
Tropical storm	USA	1900-2005	Wealth, population	No trend since 1900	Pielke et al. 2008
Tropical storm	USA	1950-2005	GDP, population	Increase since 1970; No trend since 1950	Schmidt et al. 2009
Tropical storm	China	1983-2006	GDP	No trend	Zhang et al. 2009
Tropical storm	USA	1900-2008	GDP	Increase since 1900	Nordhaus 2010
Weather (flood, thunderstorms, hail, bushfires)	Australia	1967-2006	Dwellings, dwelling values	No trend	Crompton and McAneney 2008
Weather (hurricanes, floods)	USA	1951-1997	Wealth, population	No trend	Choi and Fisher 2003
Weather (hail, storm, flood, wildfire)	World	1950-2005	GDP, population	Increase since 1970; No trend since 1950	Miller et al. 2008

Source: Bouwer in press, *BAMS*

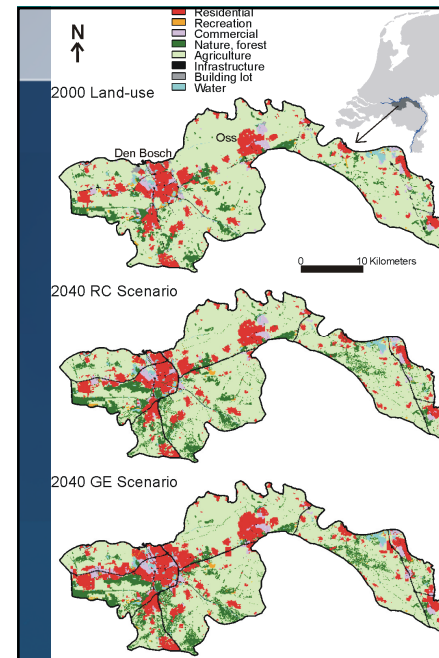
## Case 1: Loss potential (river flood)

- Flood loss modelling analysis
  - event probabilities
  - wealth increases (vulnerability)
  - land-use change (exposure)
- Climate scenarios: G, W+
- Socio-economic scenarios: RC, GE
- Land-use model
- Adaptation through dike improvement

## Case 1: Loss potential (river flood)



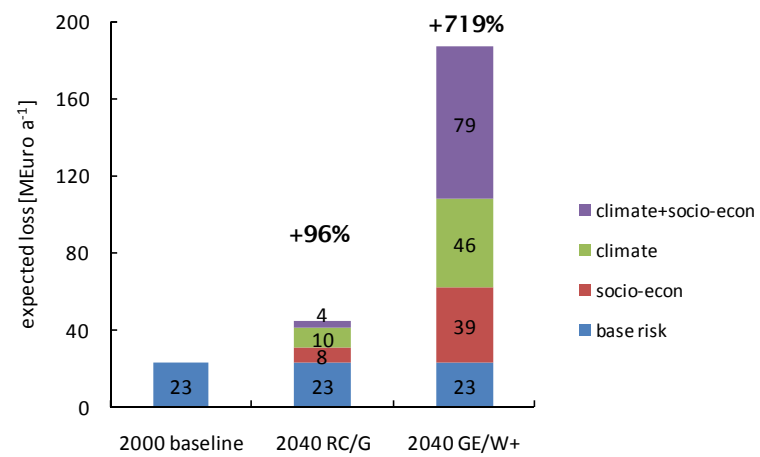
Source: Bouwer *et al.* 2010, GEC



Land-use Scanner model  
(Faculty of Economics VU,  
and PBL)

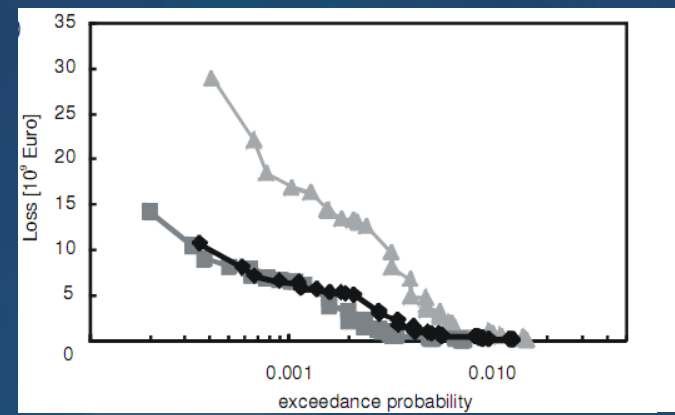
Global Economy (GE) and  
Regional Community (RC)  
socio-economic scenarios

### Case 1: Loss potential (river flood)



Source: Bouwer *et al.* 2010, GEC

### Case 1: Loss potential (river flood)



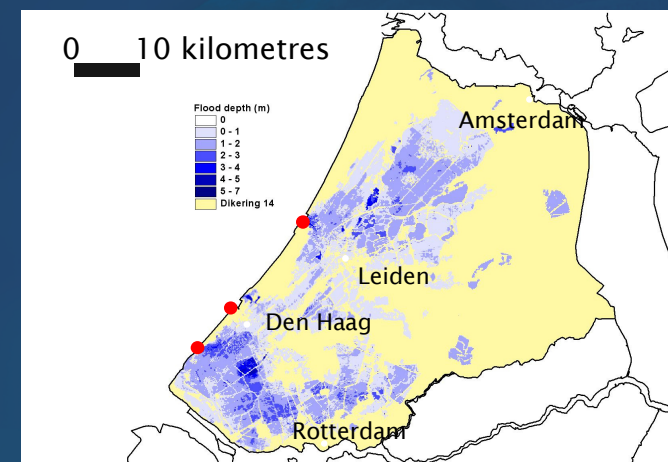
Source: Bouwer *et al.* 2010, GEC

## Case 2: casualty potential (coast and river)

- Model of mortality rates (TU Delft), based on hurricane Katrina data
- Projected population increase
- Projected land-use change
- Climate change:
  - Increased surge and river flood probability
  - Sea-level rise

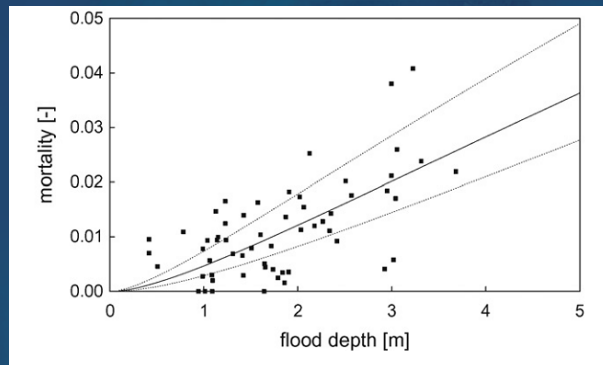
Source: Maaskant *et al.* 2009, ESP

## Case 2: casualty potential (coast and river)



Source: Maaskant *et al.* 2009, ESP

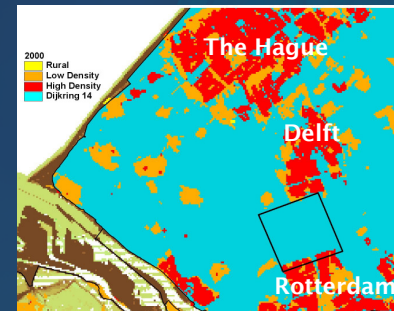
## Case 2: casualty potential (coast and river)



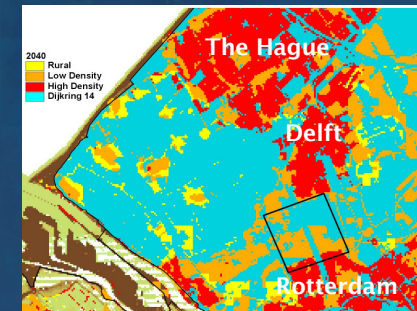
Source: Maaskant *et al.* 2009, ESP

## Case 2: casualty potential (coast and river)

Baseline: 2000

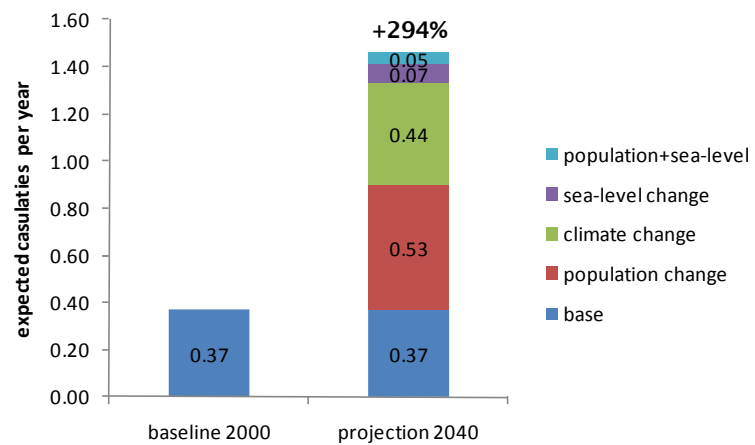


Land-use scanner model: 2040



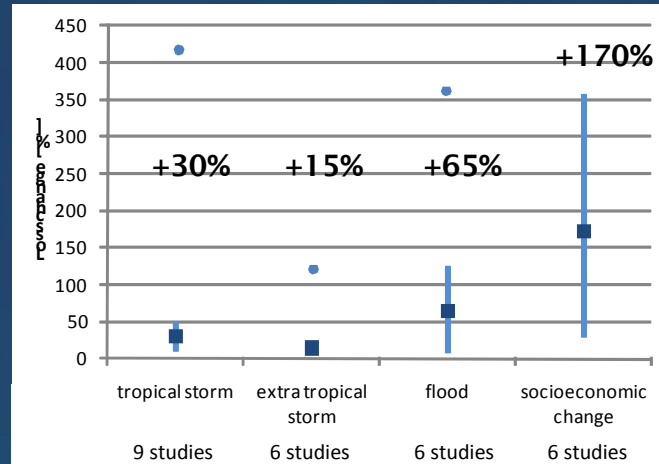
Source: Maaskant *et al.* 2009, ESP

## Case 2: casualty potential (coast and river)



Source: Maaskant *et al.* 2009, ESP

## Comparison: economic loss change in 2040



Bouwer, submitted to *Risk Analysis*

## Limitations of socioeconomic scenarios

- Exposure
  - GDP as proxy for asset values
  - Population, national level
  - Land-use from simulation models
- Vulnerability and Adaptation
  - Very little quantification

## Conclusions

- Future climate change will increase future disaster risk (especially flood risk)
- At least equal/larger effect from increasing population and asset values *for large scale hazards*
- Differences between types of weather hazards
- For small scale hazards: *uncertain*
- Amplification of driving factors
- Need to better incorporate effects exposure and vulnerability change, and adaptation in impact studies.

Thank you for your attention!

#### Key references to this work:

- Bouwer *et al.* 2007, *Science* <http://dx.doi.org/10.1126/science.1149628>
- Bouwer in press, *BAMS* <http://dx.doi.org/10.1175/2010BAMS3092.1>
- Maaskant *et al.* 2009, *ESP* <http://dx.doi.org/10.1016/j.envsci.2008.11.004>
- Bouwer *et al.* 2010, *GEC* <http://dx.doi.org/10.1016/j.gloenvcha.2010.04.002>