Climate and Water Related Disasters:

IPCC Assessments and New Approaches to Risk Management

Pavel Kabat

Pavel.Kabat@wur.nl

Wageningen University and Research Center, Netherlands

Earth System Science & Climate Change Group www.ess.wur.nl
Lead Author IPCC AR4 WG II (Water and Climate) www.ipcc.ch
Review Editor IPCC AR5 WG II www.ipcc.ch

Presented by Eddy Moors,
Earth System Science & Climate Change Group, Wageningen UR
Three categories of water problems:

- **too little water**
- **too much water**
- **polluted water**

Can be exacerbated by climate change.
Das Protokoll der Katastrophe

Vom Erlös dieser Ausgabe gehen 100.000 Euro an die Flutopfer
Increasing impacts of extreme events

Number of disasters reported

The great weather and flood catastrophes over the last forty years
Losses in US billion dollars

- Decade 1963-1979
- Decade 1970-1979
- Decade 1980-1989
- Last ten years 1988-1997

- Total economic losses
- Insured losses

Source: Munich Re Group, 1999.
Land precipitation is changing significantly over broad areas.

Smoothed annual anomalies for precipitation (%) over land from 1900 to 2005; other regions are dominated by variability.
Proportion of heavy rainfalls: increasing in most land areas
Circulation change

• Climate change is affecting storm tracks, winds and temperature patterns

• Anthropogenic forcing has likely contributed
North Atlantic hurricanes have increased with SSTs

North Atlantic Hurricanes and Named Storms (1944-2006)

Named Storms

Hurricanes

Marked increase after 1994

Atlantic 10–20°N (1944-2005)

SST

Difference (°C) from 1961–90

1940 1960 1980 2000
Major floods in 2007

[Dartmouth Flood Observatory]
Frequency of large floods has increased substantially during the 20th century.

4 x CO₂: in some areas 100-year flood corresponding to control period can occur every 2-5 years.
Extreme hydrological events
Too much water: Floods

Between 1998 and 2004, Europe suffered over 100 major floods, with
~ 700 fatalities,
~ 500 000 people displaced
~ 25 billion € insured econ. losses

In summer 2002, Europe suffered a devastating flood, with a total
material damage over 20 billion €
(highest ever recorded in Europe).
Climate change is not responsible for occurrence of a single extreme event. However, frequency of several categories of such events is likely to increase in the changed climate.

Fig. 2.32, Folland et al., 2001. IPCC WGI TAR
South Oxford 5 januari 2003
Regionally predictions generally suggest an increase in extreme rainfall.
Adaptation to CC in water sector

Hazard

Exposure

adaptive capacity

vulnerability
Exposure: World Cities exceeding 5 million residents

1950

Analysis by Munich Re
Data: U.N. Population Division
Exposure: World Cities exceeding 5 million residents

2015

Analysis by Munich Re
Data: U.N. Population Division
Stationarity lock-in in Water Engineering and Disaster Management
Adaptation
(with investments)

Climate parameter (e.g. rainfall)
Adaptation (autonomous)

Adaptation (with investments)

Climate Change

“Acceptable risk”

Climate parameter (e.g. rainfall)

Frequency

$P_2 + P_1$

$\bar{X}_2 - \bar{X}_1$

Adaptation (autonomous)
**GIS-based Risk Assessment Tool ‘HAZUS - MH’**
(Hazards in the United States for Multi Hazards: Earthquakes, Wind, Flood).

\[
\text{Risk} = \sum \left( \text{Hazard} \times \text{Assets} \times \text{Vulnerability} \right)
\]

$ / year or /event over Region probability per time $ value $0 < V < 1$

**Risk**
- **Expected Losses** for either a scenario event ($)
  or in terms of probabilistic annual losses ($/year)
- **Hazards**
  Probability per unit time of exceeding a certain
  wind speed or flood height ($P=1$ for scenario event)
- **Assets**
  Replacement Value in Dollars for Buildings or
  Infrastructure, (or $ / live !)
- **Vulnerability**
  Dimensionless Value between 0 and 1. It is the
  Fraction of Replacement Value of a Given Asset,
  Given the Hazard Level it is exposed to.

**HAZUS-MH also has a Built-in Economic Model for Damage-Related, Indirect Losses.**
Risk Management Tools: Minimizing the Risk via Mitigation and Adaptation Measures (Let’s use the Risk Equation and GIS-based Models!):

\[
\text{Risk} = \text{Sum} \ (\text{Hazard} \times \text{Assets} \times \text{Vulnerability})
\]

- Mitig.: Reduce GW + SLR Hazards
- Adapt.: Land Use Planning & Zoning,
  Considerate Placements of new Assets,
  Relocation of Essential Assets,
  Levees & Dams (?),
  Equity Issues.

or by

\[
\text{Risk} = \text{Sum} \ (\text{Hazard} \times \text{Assets} \times \text{Vulnerability})
\]

- Adapt.: Good Engineering, Construction Quality-Control,
  Codes and Code Enforcement, Retrofitting,
  Raising Assets in Place
  Reinforcing Levees and Pump Stations
World Trade Center Site Redevelopment “Bathtub”
Thank you!

Dresden (Zwinger), August 2002