Future Challenges and Needs for Natural Hazards Research

The Economic Dimension

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IIASA

International Workshop
Disaster Risk Reduction:
Dialogue between Scientists and Stakeholders

European Commission, Directorate for Research, and
the United Nations International Strategy for Disaster Reduction (UNISDR)
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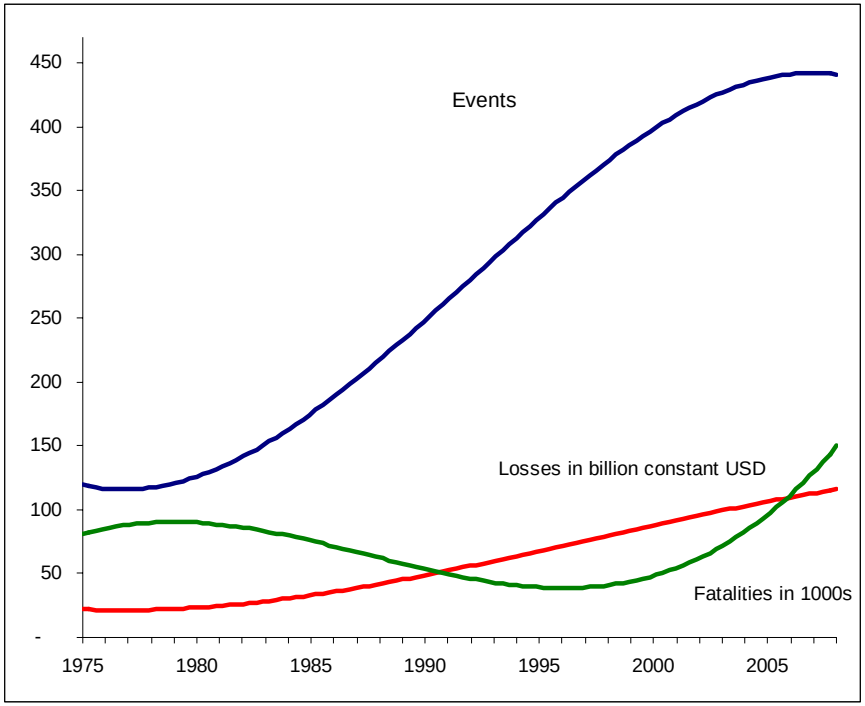
Brussels, European Commission

Global trends in disasters



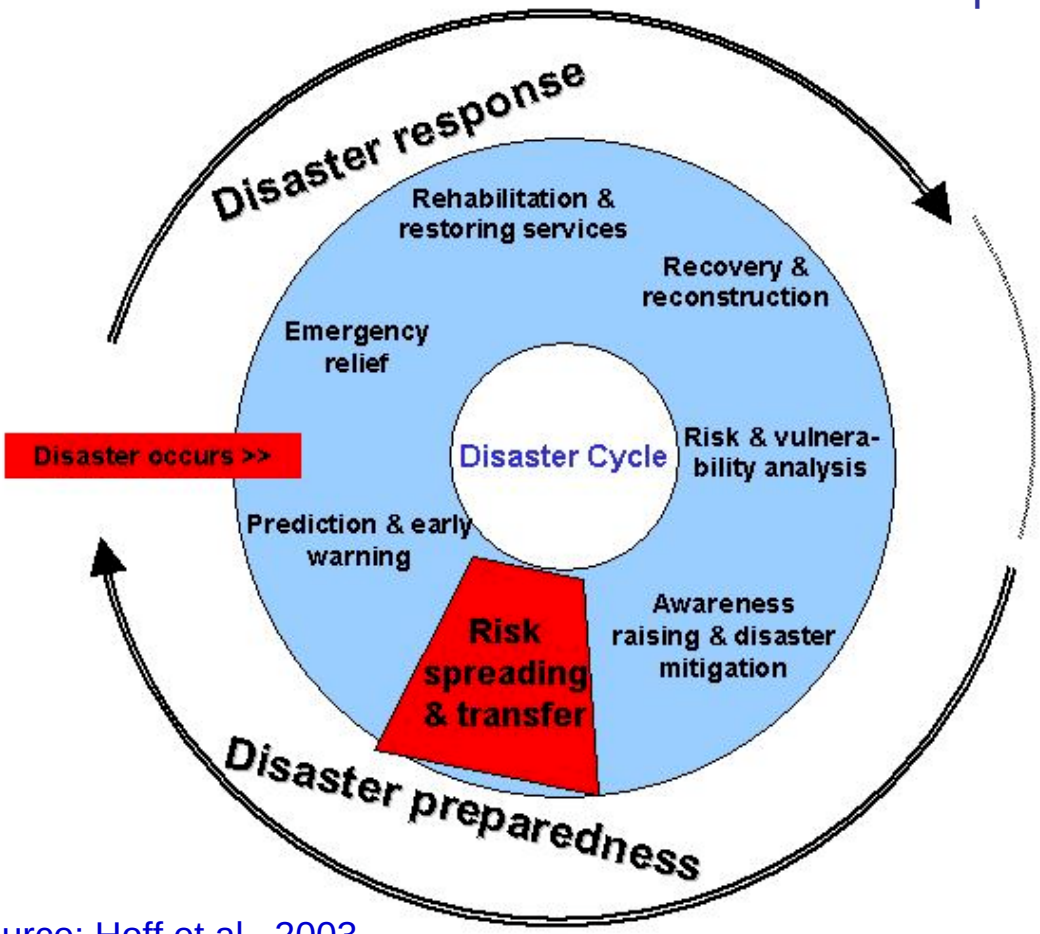
Trends in natural disaster impacts

Data source: EM-DAT, Université Catholique de Louvain

- Impacts today mostly driven by socioeconomic factors: population, population density, wealth, and vulnerability
- Some evidence that climate change is having an impact
- IPCC, 2008: anthropogenic climate change *likely* to *very likely* to lead to increases in intensity and frequency of weather extremes

Insufficient investment into DRM

Post-disaster: Impact and relief



Source: Hoff et al., 2003

Pre-disaster: Risk

95% ex-post
vs
5% ex-ante

→ Need for better balance

Many reasons:
One being a lack of appropriate information on risks, as well as little information on the costs and benefits of disaster risk management/adaptation

What role for economics?

1. Risk Assessment: Costing impacts and risk
   - “Assets”: Health, environment, property
   - “Flows”: Indirect, social costs and risks

2. Risk Management: Supporting the prioritization of DRM and adaptation (given scarce resources and other priorities)

3. Risk governance: devising and assessing instruments in a process based approach accounting for differences in preferences

Demand for information
The European dimension

- Europe vulnerable to disasters today, key focus for EU adaptation strategy (White paper) is on managing climate variability

- Impact and risk information (maps) exist in some EU member states, yet rather heterogenous in nature

- Some questions being asked:
  - Consistent picture on risks over Europe
  - Future risks
  - Ability to manage and share risks today and in future
  - Costs and benefits, challenges and tradeoffs of DRM and adaptation

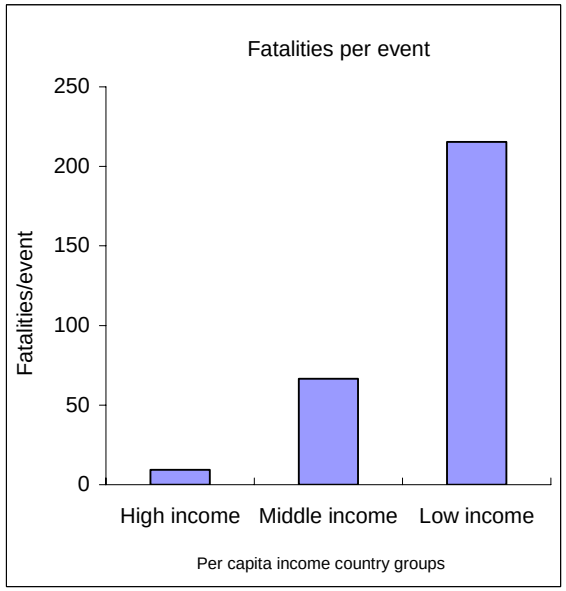
Demand for information
The international dimension

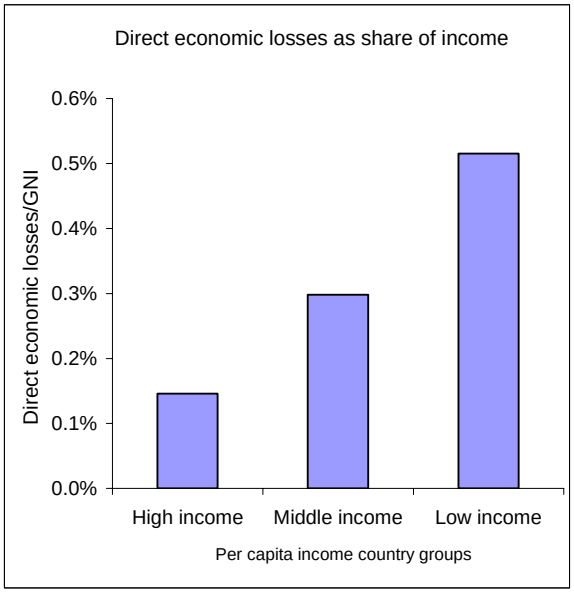
- The *UNFCCC Bali Action Plan* addresses risk management prominently and suggests to focus on developing countries that are particularly vulnerable to the adverse effects of climate change

- Adaptation fund has been created

- Questions:
    - Most vulnerable households and countries that should be eligible?
    - Current and future ability to adapt?
    - What are costs of adaptation and “residual damage costs”?

Developmental context: Differential ability to manage risks





Direct impacts of disasters 1980-2004 according to per capita country income groups

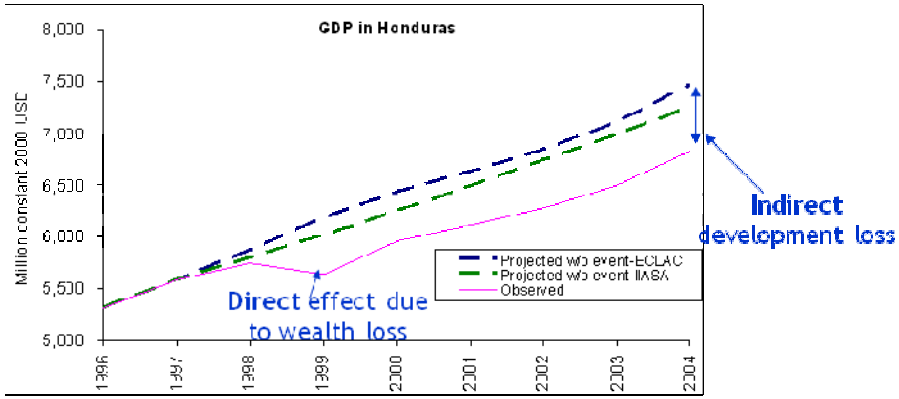
Data source:
Munich Re, 2005

Developmental context: Differential ability to manage risks

Large exposure coupled with low resilience can lead to large indirect social impacts and risks:

Aftermath of Hurricane Mitch 1998 in Central America

Honduras:
total assets loss ca. 20%



Observed GDP in Honduras with events vs. projected growth without events. Source: Zapata, 2008; World Bank, 2007; own calculations

Macro impact: GDP

Nicaragua:
Direct loss: 50% of bean, 20% of maize, and 30% of rice crops lost

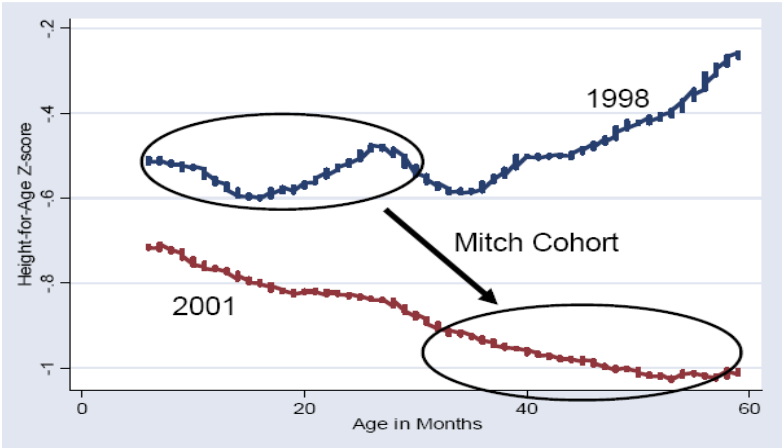
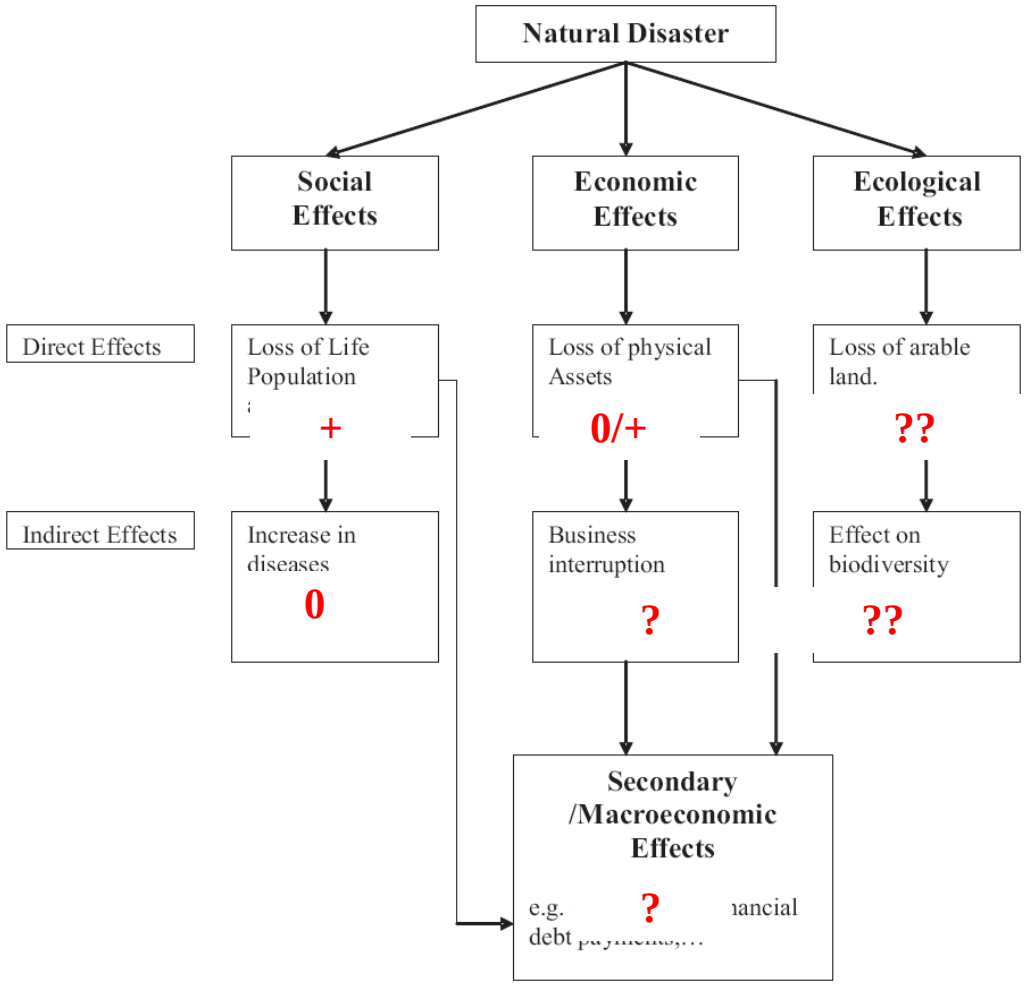


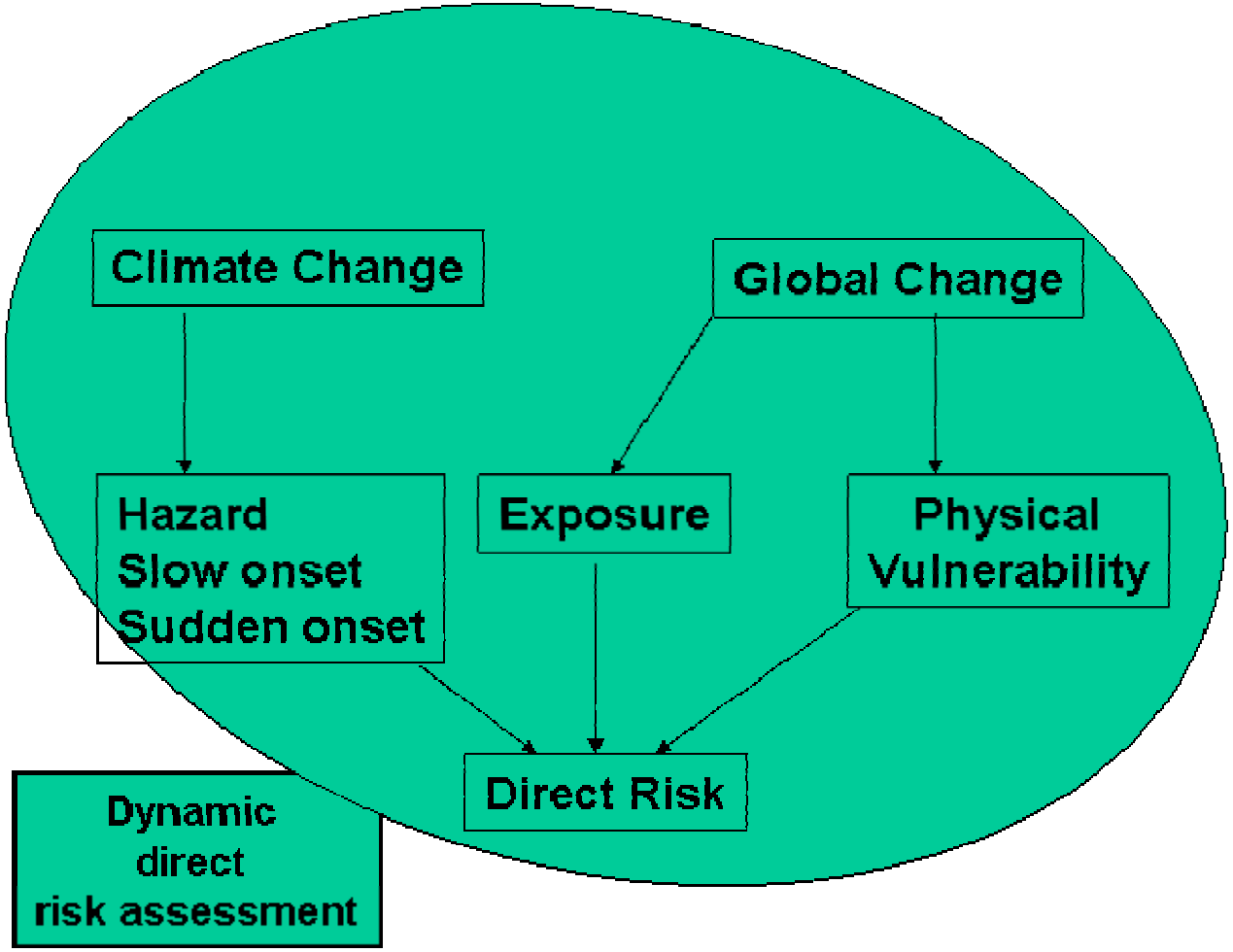
Figure 1. Height-for-Age Z-score in Nicaragua in 1998 and 2001

Micro impact: Malnutrition, and may lead to stunted growth

1. Overview over effects

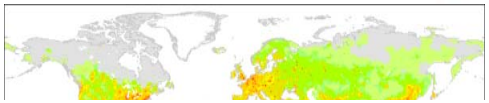


Costing direct risks

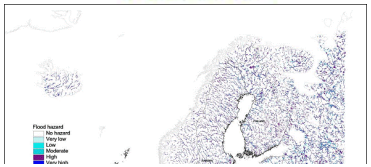


IIASA CATSIM model

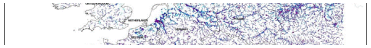
Implementing the risk triangle



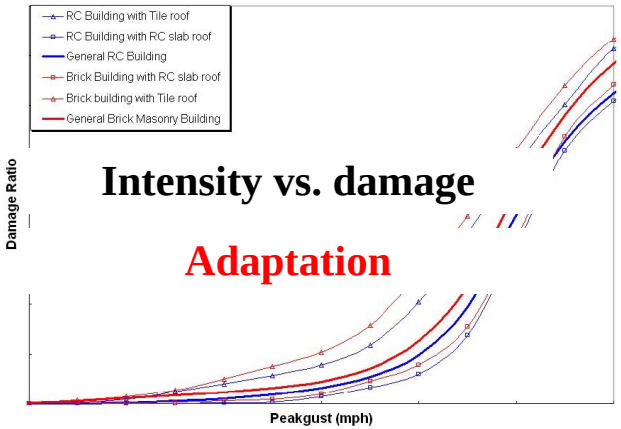
Exposure: population, capital stock and environment exposed



Intensity and frequency



Climate change

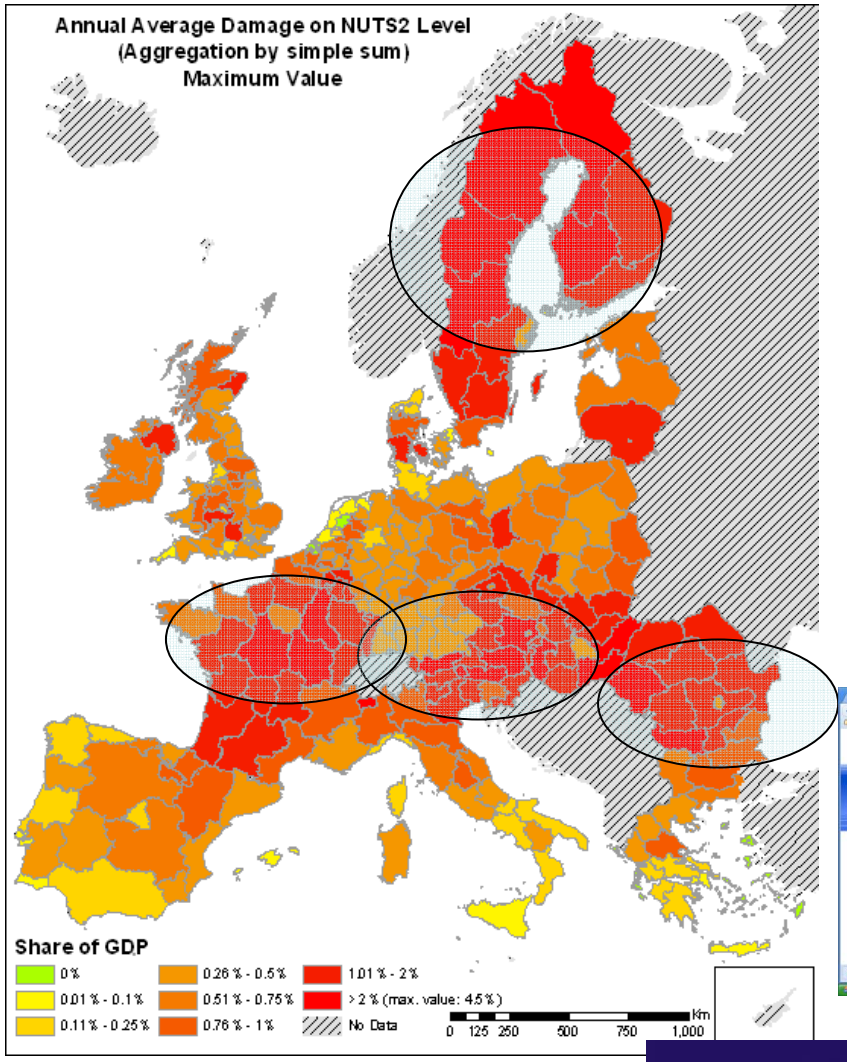


Intensity vs. damage

Adaptation

Europe: ADAM and PESETA projects costing direct flood risk

Maximum annual average flood damage for European provinces and regions (NUTS 2 level) as a percentage of GDP for today's climate regime



Source: Lugeri et al., 2009

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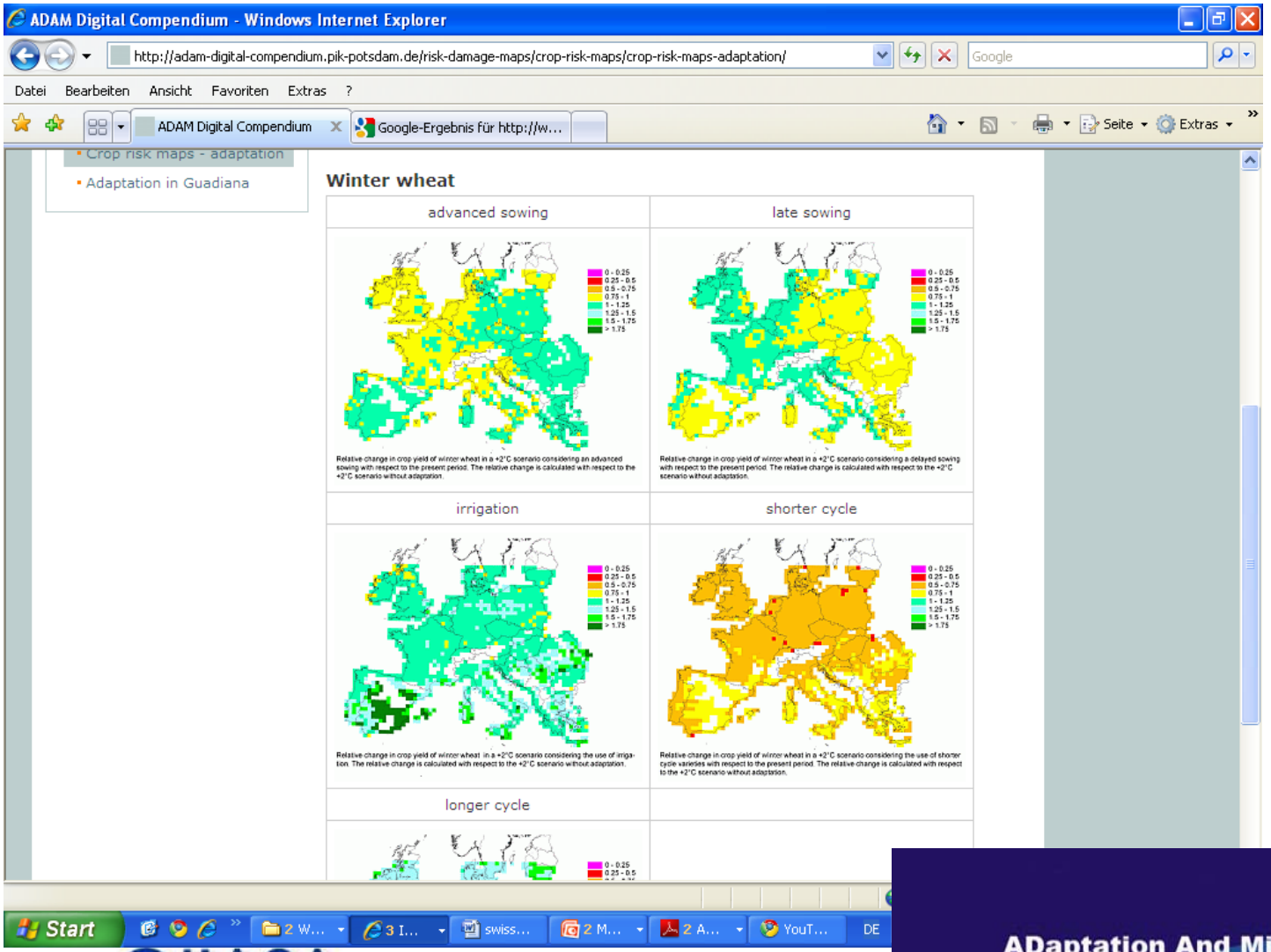
ADAM
ADaptation And Mitigation Strategies
Supporting European Climate Policy

Europe: Drought risks to crops with climate change



ADAM digital compendium

ADAM
ADaptation And Mitigation Strategies
Supporting European Climate Policy

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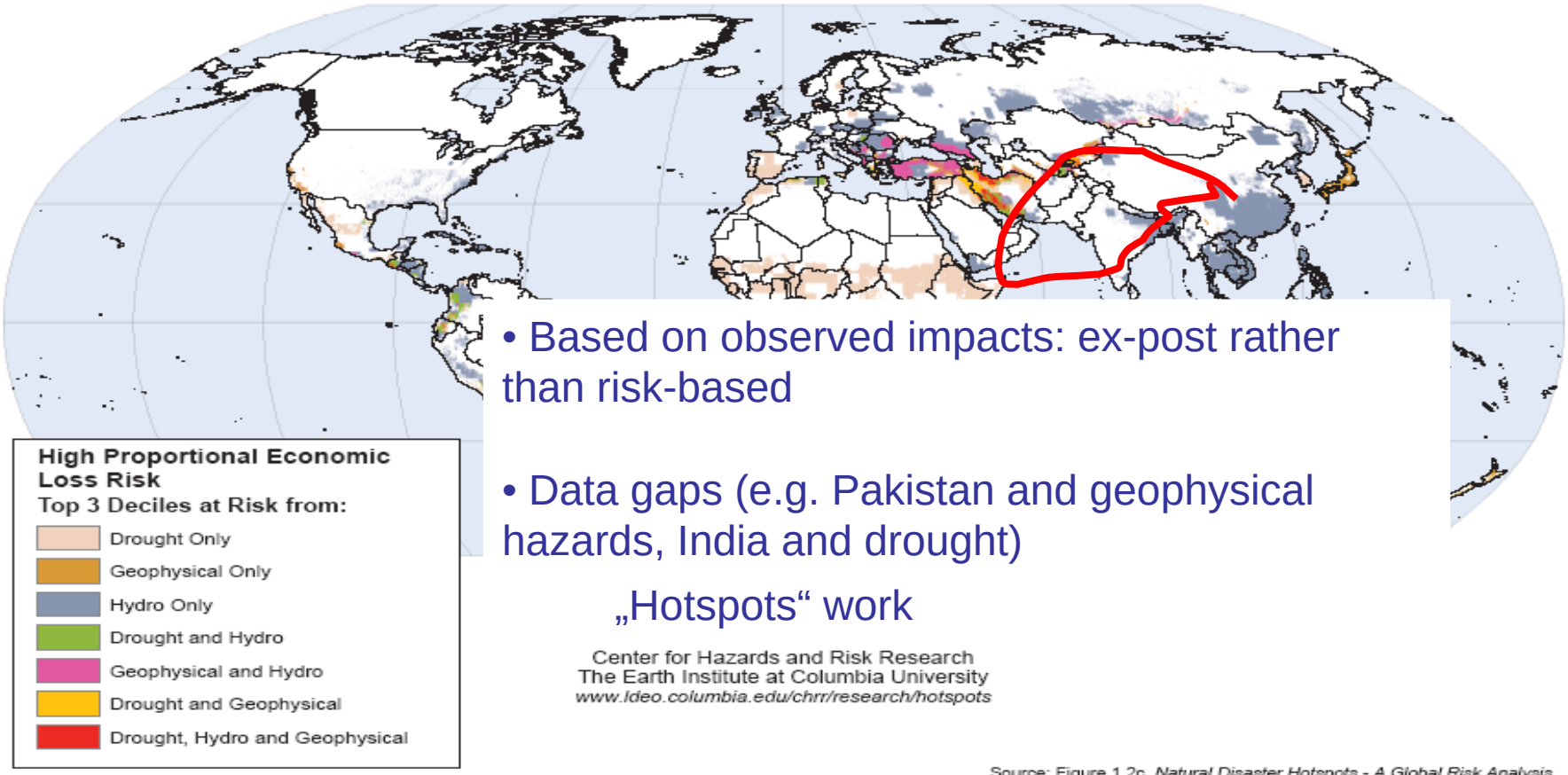
World: Spatially resolved information and data exists and is being improved, yet needs to better be related to relevant decisions



Note: Geophysical hazards include earthquakes and volcanoes; hydrological hazards include floods, cyclones, and landslides.

- Based on observed impacts: ex-post rather than risk-based
- Data gaps (e.g. Pakistan and geophysical hazards, India and drought)

„Hotspots“ work

Center for Hazards and Risk Research
The Earth Institute at Columbia University
www.ldeo.columbia.edu/chrr/research/hotspots

Source: Figure 1.2c. *Natural Disaster Hotspots - A Global Risk Analysis*
©2005 The World Bank and Columbia University

Regional and global open source risk models being built as PPPs

GEM

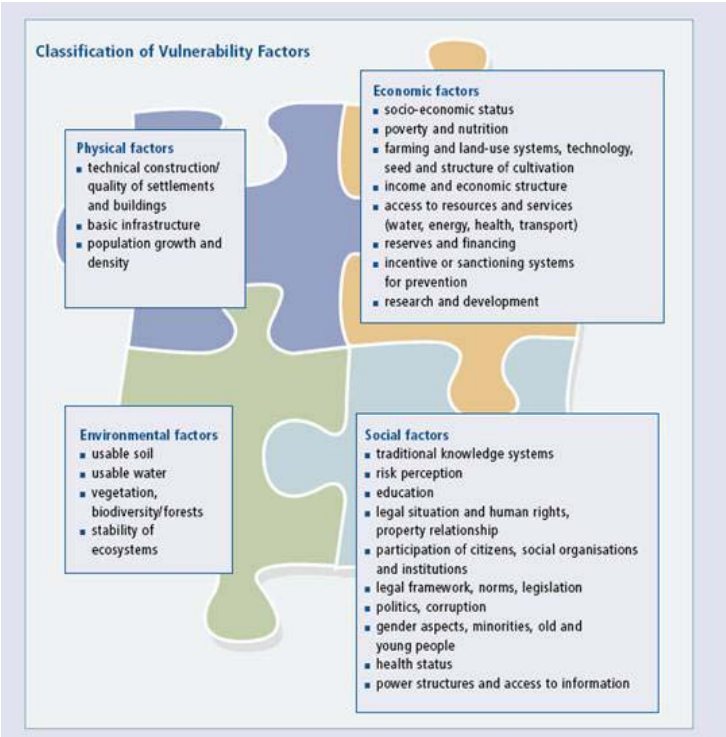
GLOBAL EARTHQUAKE MODEL

CAPRA Central American Probabilistic Risk Assessment Portal

AGORA

Alliance for Global Open R

From direct to indirect: Vulnerability and Resilience

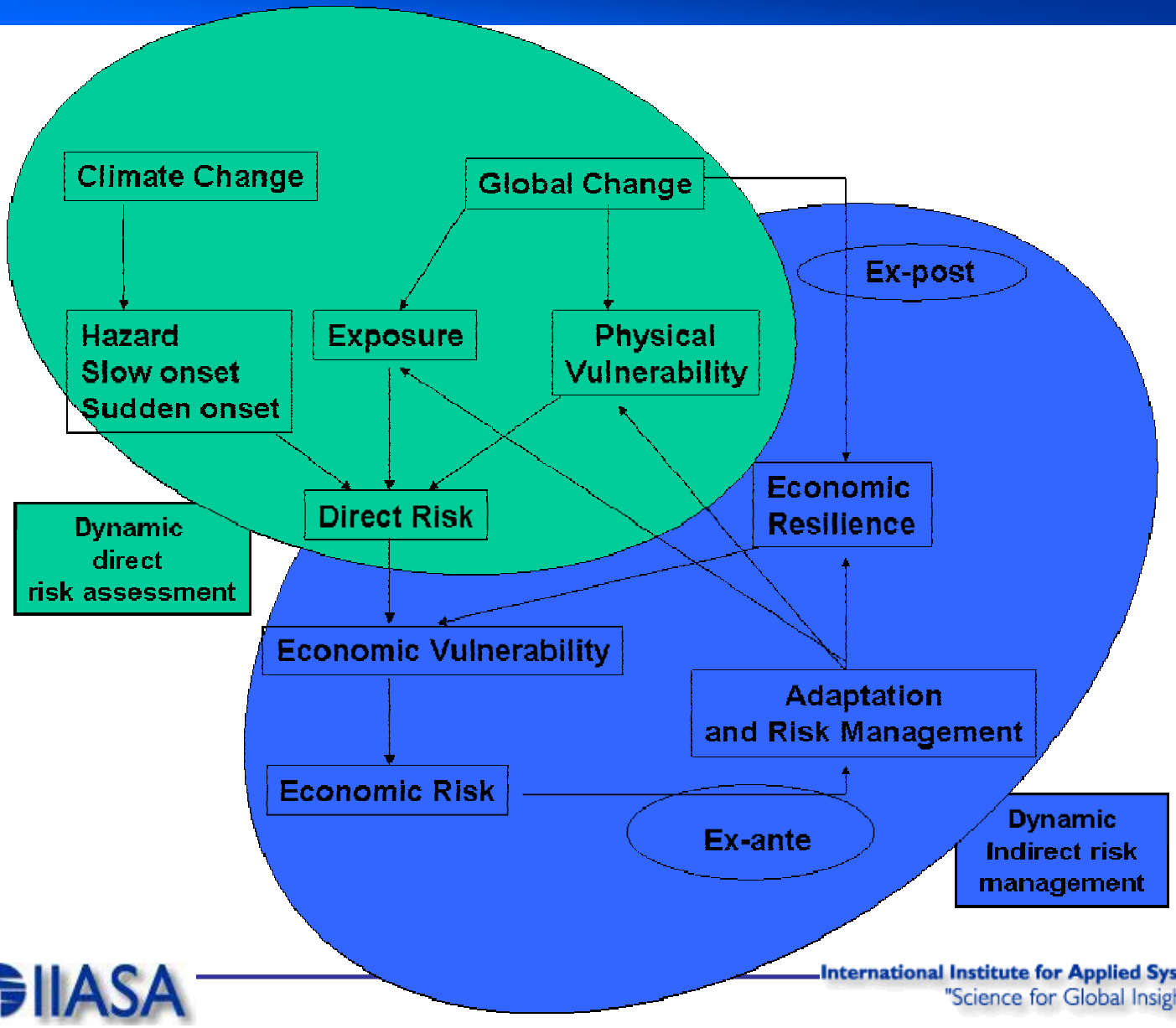


Classification of vulnerability factors
Source: Kohler et al. 2004

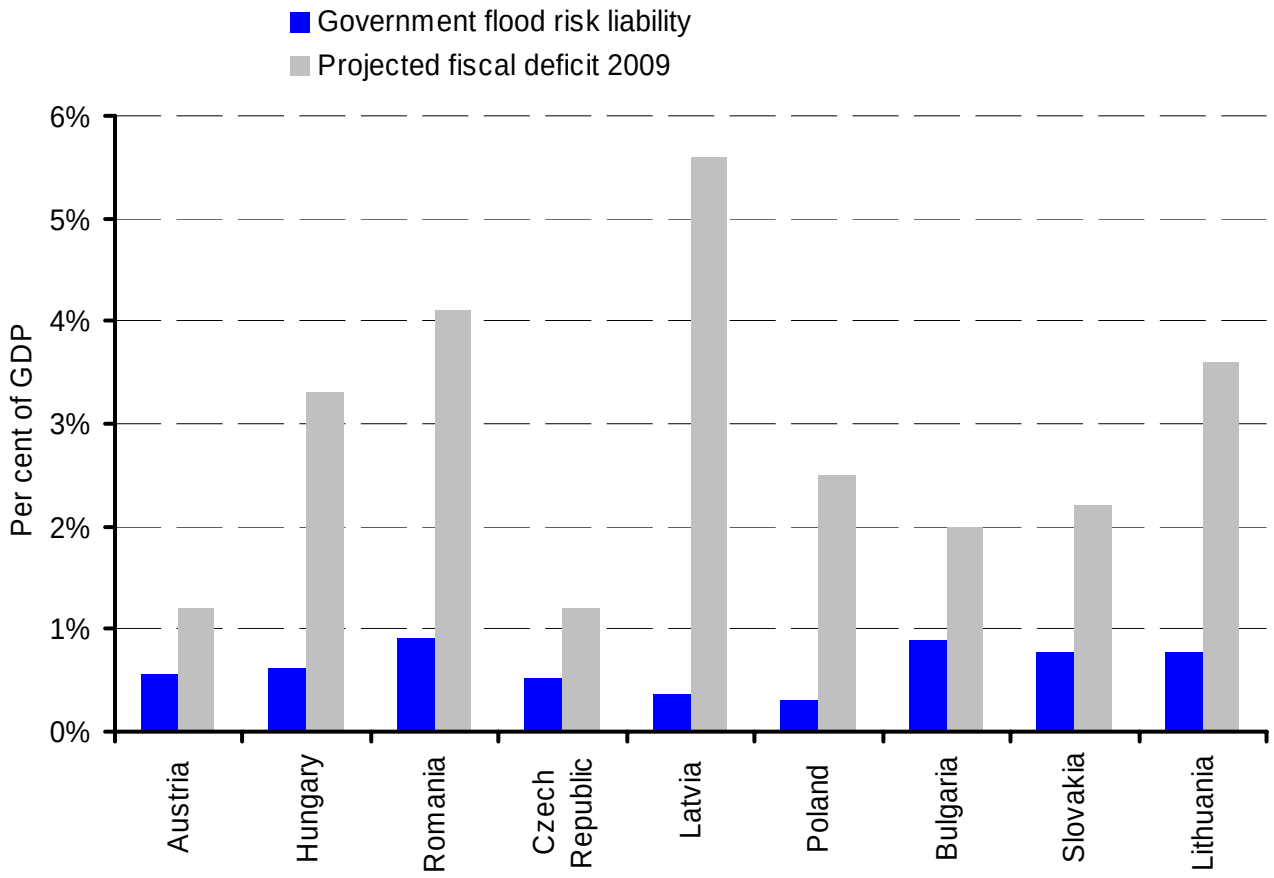
Operationalize vulnerability (and resilience) and integrate with risk

→ Risk is better governed and understood
(there are no „Vulnerability Managers“)

From direct to indirect: Vulnerability and resilience



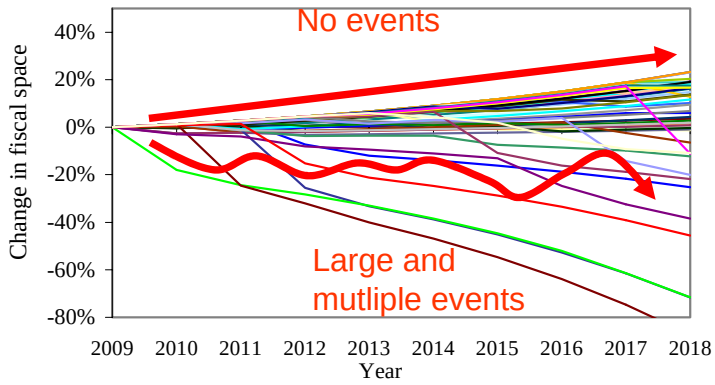
Hidden government disaster liabilities in Europe



→ Annualize flood risks and translate into government "hidden" liabilities

Indirect risks: fiscal costs

Austria‘s fiscal position over time when considering flood exposure



Fiscal position risky due to large exposure, in 2002 fiscal crisis after large scale flooding

2. Costing DRM and adaptation

Building a culture of prevention is not easy. While the costs of prevention have to be paid in the present, its benefits lie in a distant future. Moreover, the benefits are not tangible; they are the disasters that did NOT happen. (Kofi Annan 1999)

→Uncertainty

→ Myopia

→ Discounting

Tools for „costing“

- Tools exist and are being applied, CBA a prominent one

- Yet, limited number of systematic studies, small evidence base and limited, but increasing interest

- Some knowledge about structural, hard measures (building dams)
- Less known on soft measures (preparedness etc.)
- Benefits of informal DRM and adaptation largely unknown

Using cost Benefit Analysis

Table 1 | Sample results from cost-benefit analysis of risk management measures in specific case contexts*

Sample interventions	Estimated B/C Ratio**	Change in B/C ratio with Climate Change
UTTAR PRADESH FLOOD MANAGEMENT		
Construction of embankments for flood control (existing programme). Ratio shown reflects indirect costs and benefits. A strict engineering analysis that excludes indirect costs and benefits would, under current climatic conditions, give a B/C ratio of 4.6.	1	Likely to decline
Maintenance of existing embankments	2	Stable
Distributed mix of community based interventions	2.5	Increases
UTTAR PRADESH DROUGHT MANAGEMENT		
Groundwater irrigation (risk reduction alone)	1.6	Increases to 2
Index based insurance programme	2	Declines to 1.2
Combination of insurance and irrigation	2.2	Stable
RAWALPINDI URBAN FLOOD MANAGEMENT		
Expressway/Channel	1.88	Not analyzed
Community pond	8.55	Likely to be robust
River improvement by removing blockages at key choke points	25	Likely to be robust or increase
Early warning system as currently installed. This is a dedicated early warning system that was installed following a major flood event in 2002. The benefit-cost ratio is not representative of other early warning systems.	0.96 Cost per life saved approximately USD 44,000	Benefits would increase with anticipated increases in flooding - but the greatest increases would come with improvements in design
Relocation of population and restoration of the flood plain	1.34	Likely to increase
NEPAL QUALITATIVE COST BENEFIT ANALYSIS		
Flood control embankments along Bagmati River: Evaluation included indirect benefits and costs as well as their distribution	Costs appear to exceed benefits	Appears likely to decline
Distributed mix of community level interventions: Note benefit and cost characteristics are qualitatively different from those associated with embankments and in many cases can't be directly compared.	Benefits appear to exceed costs	Appears likely to increase

* All B/C ratios shown are for 10% discount rates. Assumptions and details underlying all ratios are discussed extensively in the relevant chapters below.
** A note for non-economists: a B/C ratio above 1.0 indicates benefits outweighing costs. The higher the number, the higher the benefit.

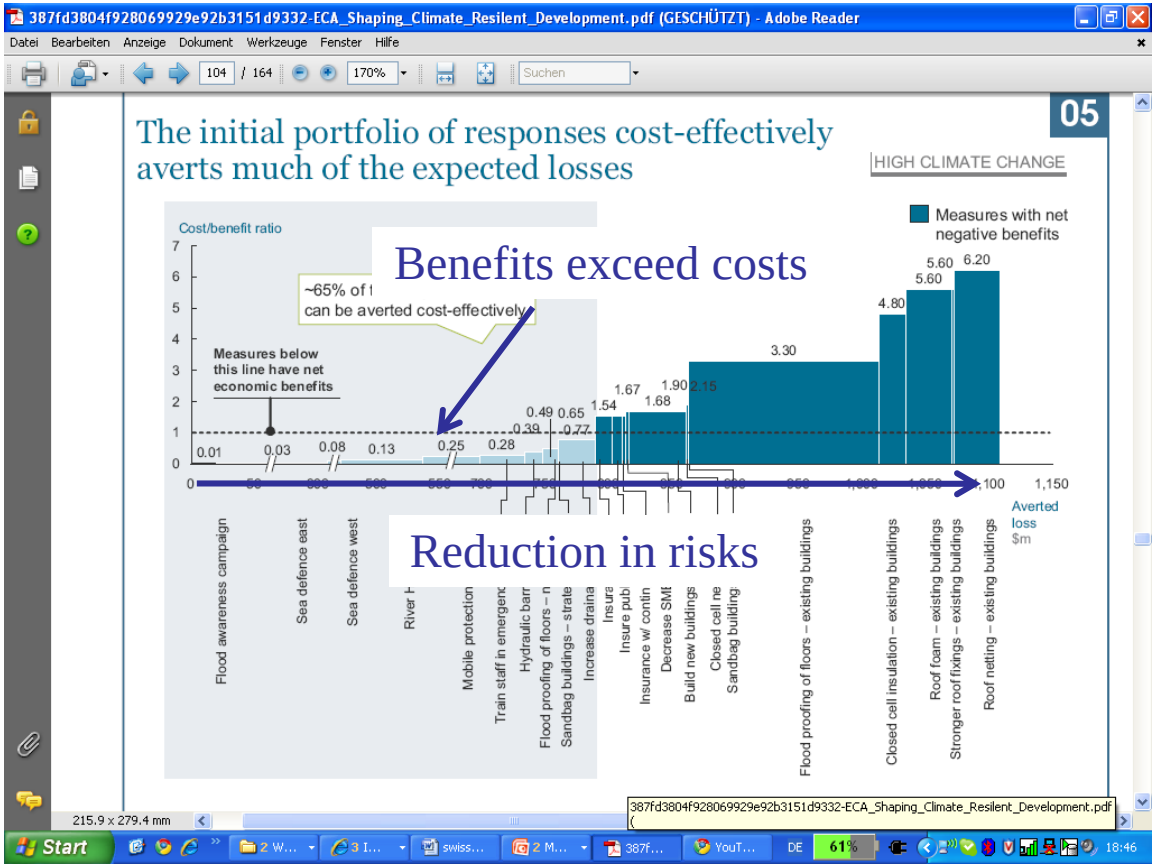
Limitations to CBA - generally

- CBA with important challenges
  - Which benefits to include? Use vs. abuse…
  - Lack of accounting for the distribution of benefits and costs in CBA
  - Challenges with monetizing non-market impacts: loss of life, environment
  - Time and scale

- Alternatives/complements:
  - Multicriteria analysis
  - Cost-efficiency analysis
  - ..

Risk management/adaptation cost curves?

Multi hazard case: Hull, UK



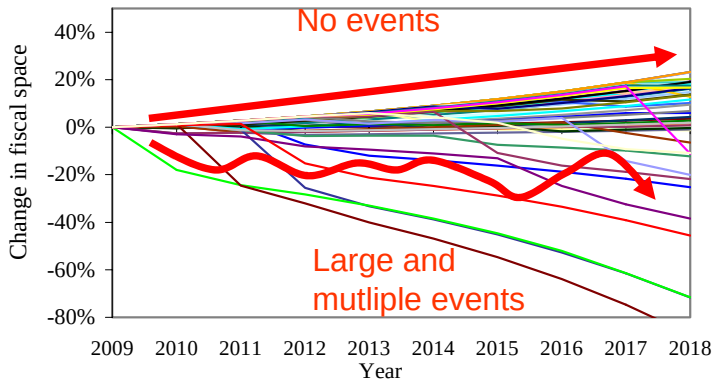
Source: Economics of Adaptation Working Group, 2009 (Swiss Re, Mc Kinsey, EC etc)

Questions:

- Uncertainties
- Dynamic effects
- Interactions
- Financial rather than social costs: who pays?
- Frictional costs

Modelling the costs and benefits of risk management dynamically

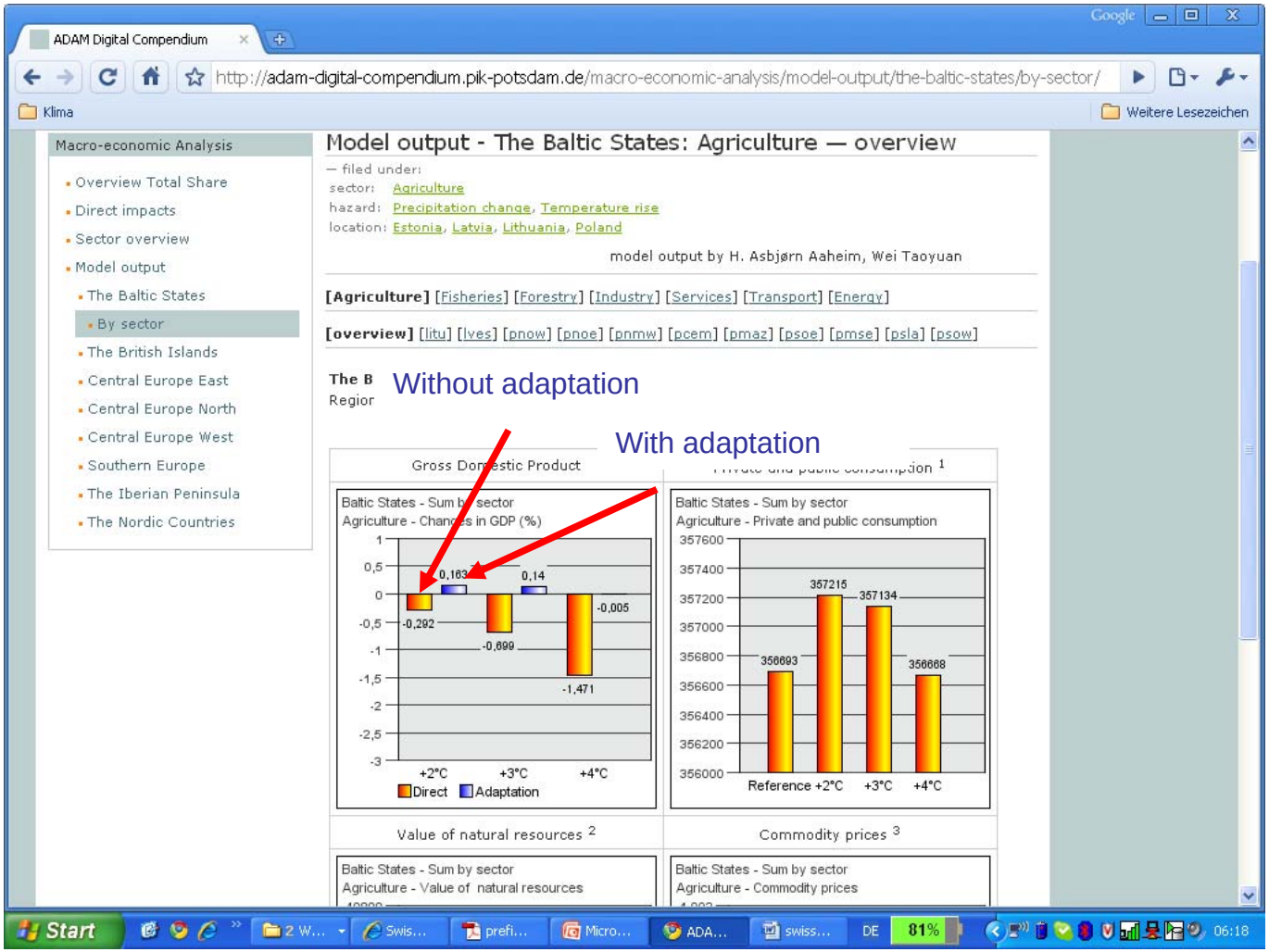
Austria's fiscal position when considering flood exposure



Fiscal position risky due to large exposure, in 2002 fiscal crisis after large scale flooding

One option:
Building up a reserve funds leads to less volatility, in bad years but less funds available in good times: tradeoff!

Assessing the management of drought risk and climate change



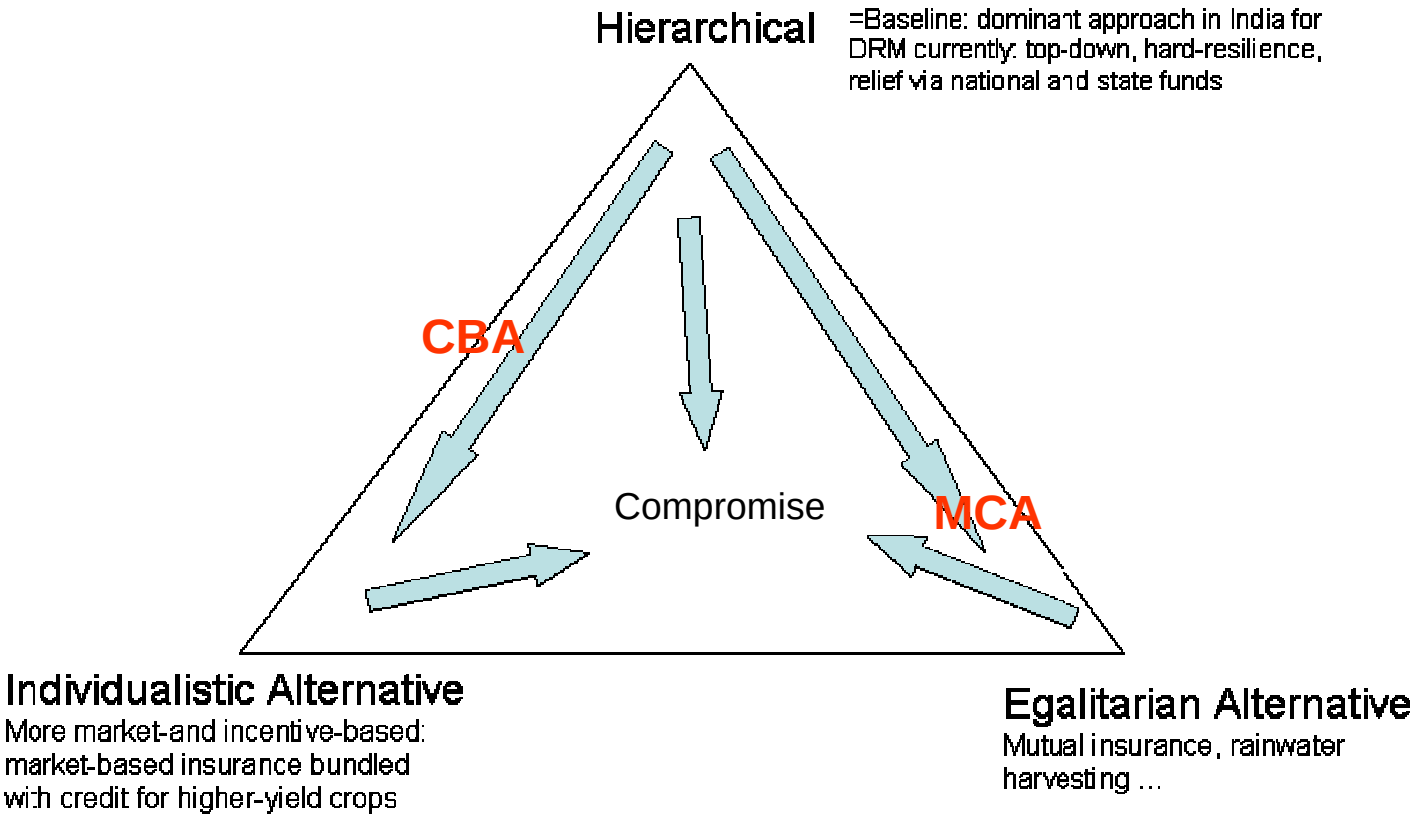
3. Ethical choices in DRM require a process beyond models

Efficiency argument: Disaster risks should be responsibility of those who are located in high-risk areas to discourage settlement in these areas and to encourage individual mitigation measures.

Equity argument: There is a need for social solidarity with disaster victims to help poor and those living or working in high-risk areas

Identification of risk reduction interventions relatively straightforward, but compromise more complicated

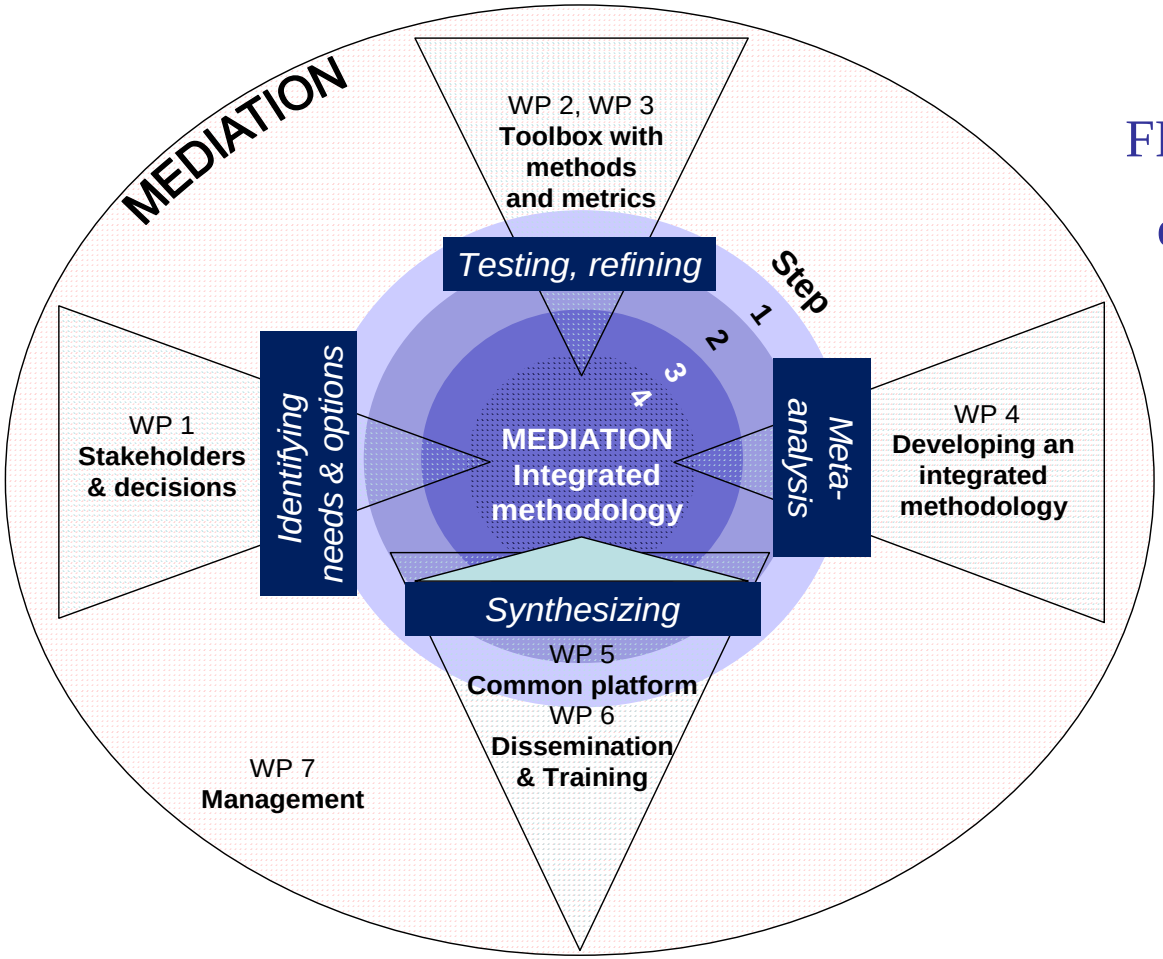
Stakeholder processes useful for reconciling preferences and finding compromise



Stakeholder orientation

- Do not optimize over unknown preferences
- Raising awareness and deeper understanding of disaster risks
- Development of risk management strategies for disaster risk management
- Mutual learning exercise: research & implementation

EU projects today standardly consider stakeholder views and preferences in project design



FP 7 project MEDIATION

on adaptation to climate change in Europe

to start 1/1/2010

To conclude

1. Need for more EU wide and global consistency in direct risk assessment, including uncertainties

2. Indirect, social risk modelling with larger gaps, but of increasing importance to gauge the opportunity costs and scarcities

3. Models ideally risk based: operationalize vulnerability and link to risk

4. DRM Options: Quantitative information useful and CBA important, but need to go beyond CBA , as well as consider effects more dynamically

5. Design processes with stakeholders: Not optimization, but focus on interaction, simulation, interaction and revision

To conclude

5. Risks in Europe: distribution of risks seems to matter most:
   Flooding in Eastern Europe, droughts and forest fire in Southern E.
   → Fairness and risk sharing options as important mechanisms (e.g., by cohesion funding)

6. Risks Outside Europe: sheer scope of the problem large
   → Assess the support needs for vulnerable households, businesses and governments and identify success models to reduce risks
   → Important role for EU research