Risk and adaptation to extreme events

-Bangladesh GGI project-

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GGI seminar

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Outline

- Project overview
- Model
- Results
- Issues and discussion

Bangladesh project

- Exemplary analysis of current and future financial and economic impacts of and adaptation to climate-related extreme events consistent with downscaled IIASA SRES GDP and population change scenarios

- Addresses major questions of disaster risk and climate change research communities:
  - How do the drivers of social/economic and natural systems affect potential extreme event impacts and risks in the future?
  - Climate change versus socio-economic drivers?
  - Scope for adaptation, costs and benefits?

- Bangladesh: most flood-prone country in the world

Risk and Uncertainty

- IPCC AR4, WG II, Ch.2: "Risk management is a useful framework for decisionmaking and its use is expanding rapidly in climate change impact, adaptation and vulnerability assessment"
- Knight: "Risk is measured Uncertainty."
- Degrees of risk and uncertainty:
  1. Complete Uncertainty:
     Outcomes unknown, probabilities unknown
  2. **Subjective Uncertainty (SRES?)**
     Outcomes known, probabilities unknown
  3. **Risk: objective uncertainty (our study)**
     Outcomes and probabilities known (within uncertainty ranges)
  4. Certainty

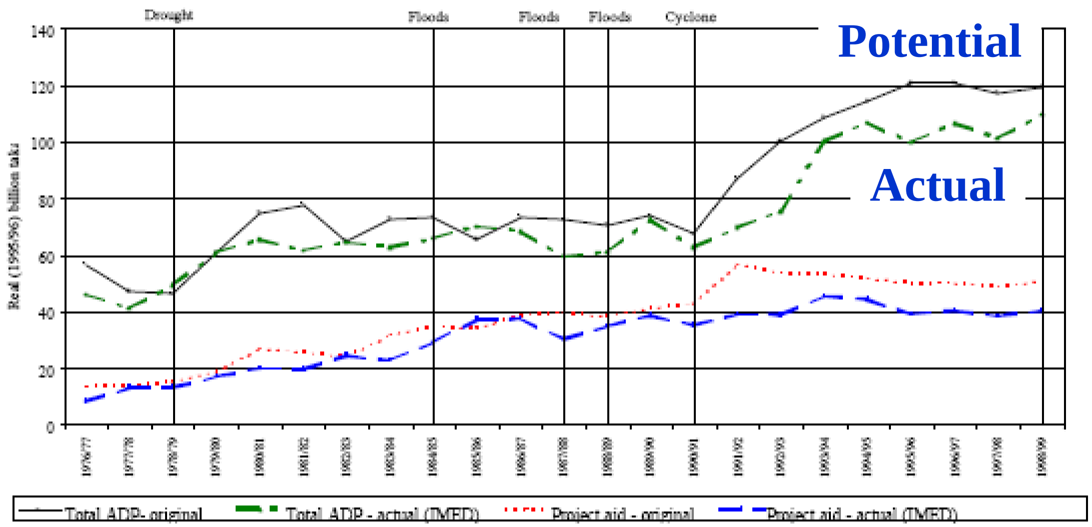
Extreme events and adaptation
-planned and public adaptation decision problem-

	Public	Private
Planned	Adaptation to Natural Disasters	
Autonomous		

→ **Public sector institutions as key agents,**
to large extent national–level decision-problem

Empirical evidence on economic impacts

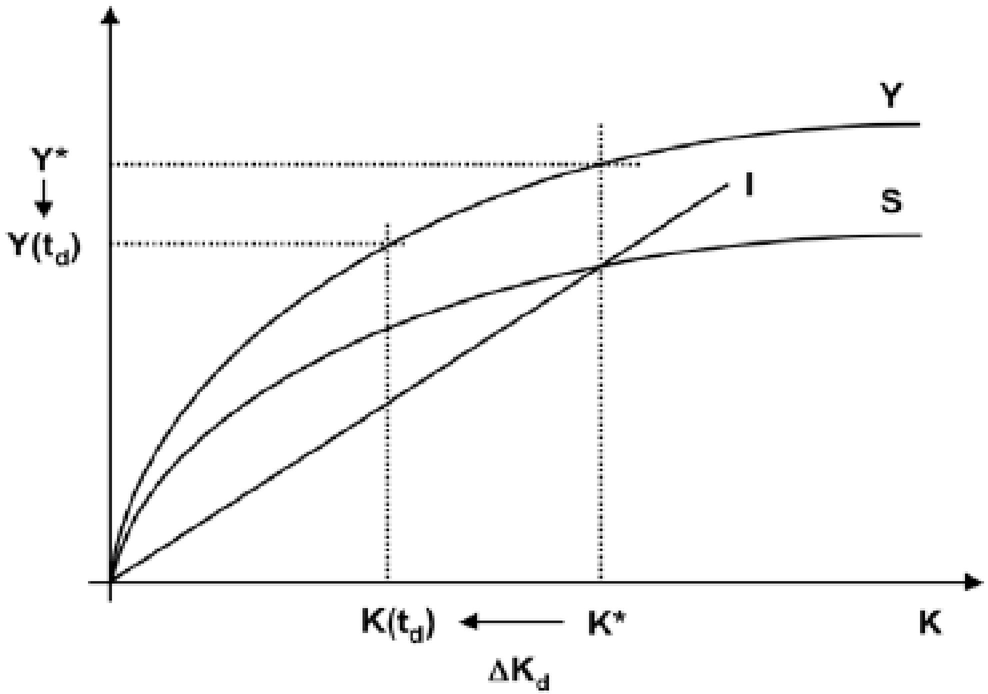
Figure 4.3: Bangladesh - ADP actual and original budgeted expenditure, 1976/77-1998/99 (real 1995/96 billion



Source: GoB Planning Commission and IMED

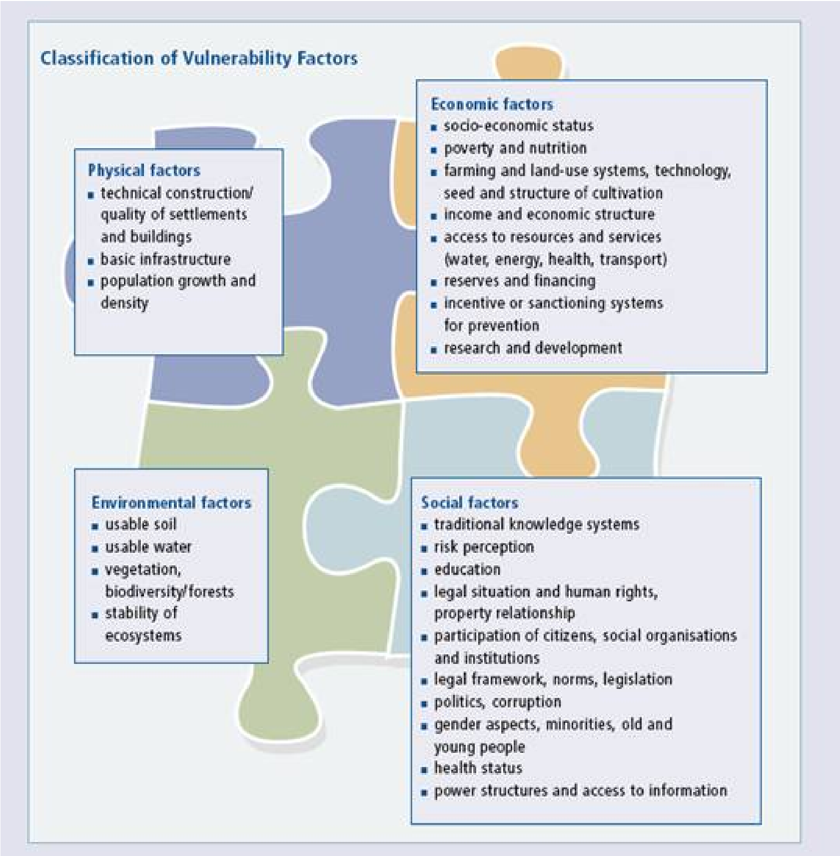
Potential vs. actual Annual Development Program spending in Bangladesh

Economic impact



Source: Zenklusen, 2007

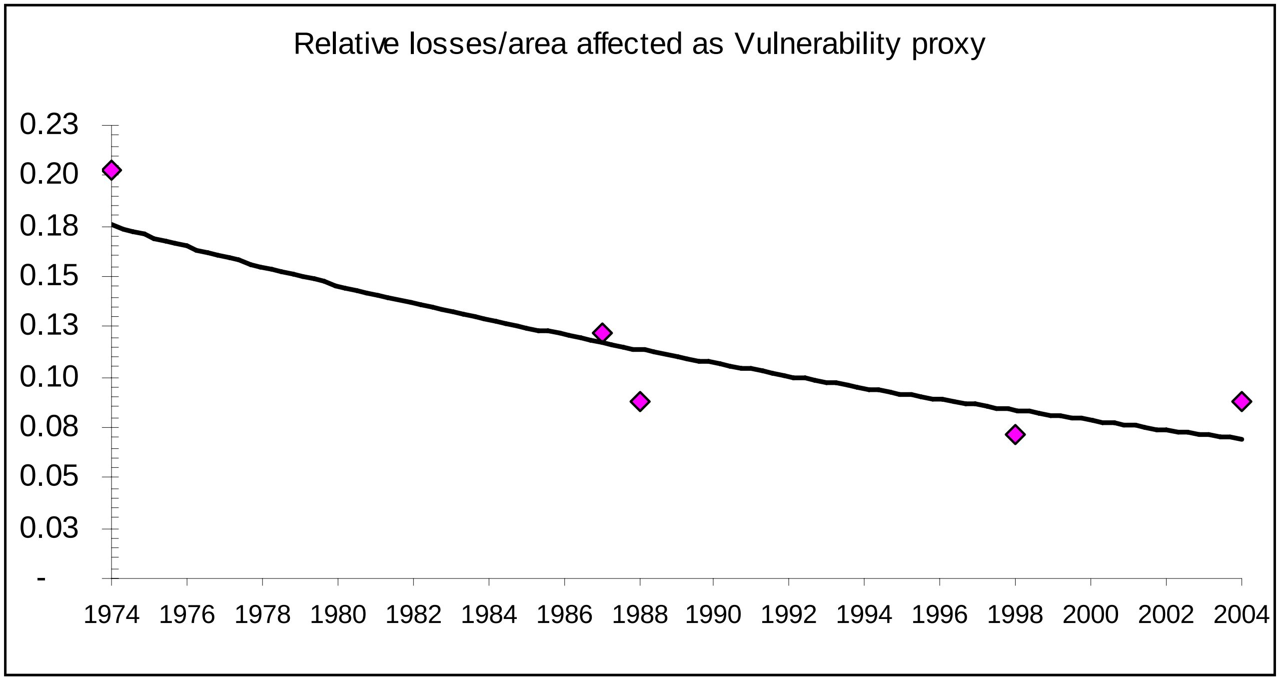
Vulnerability and adaptation



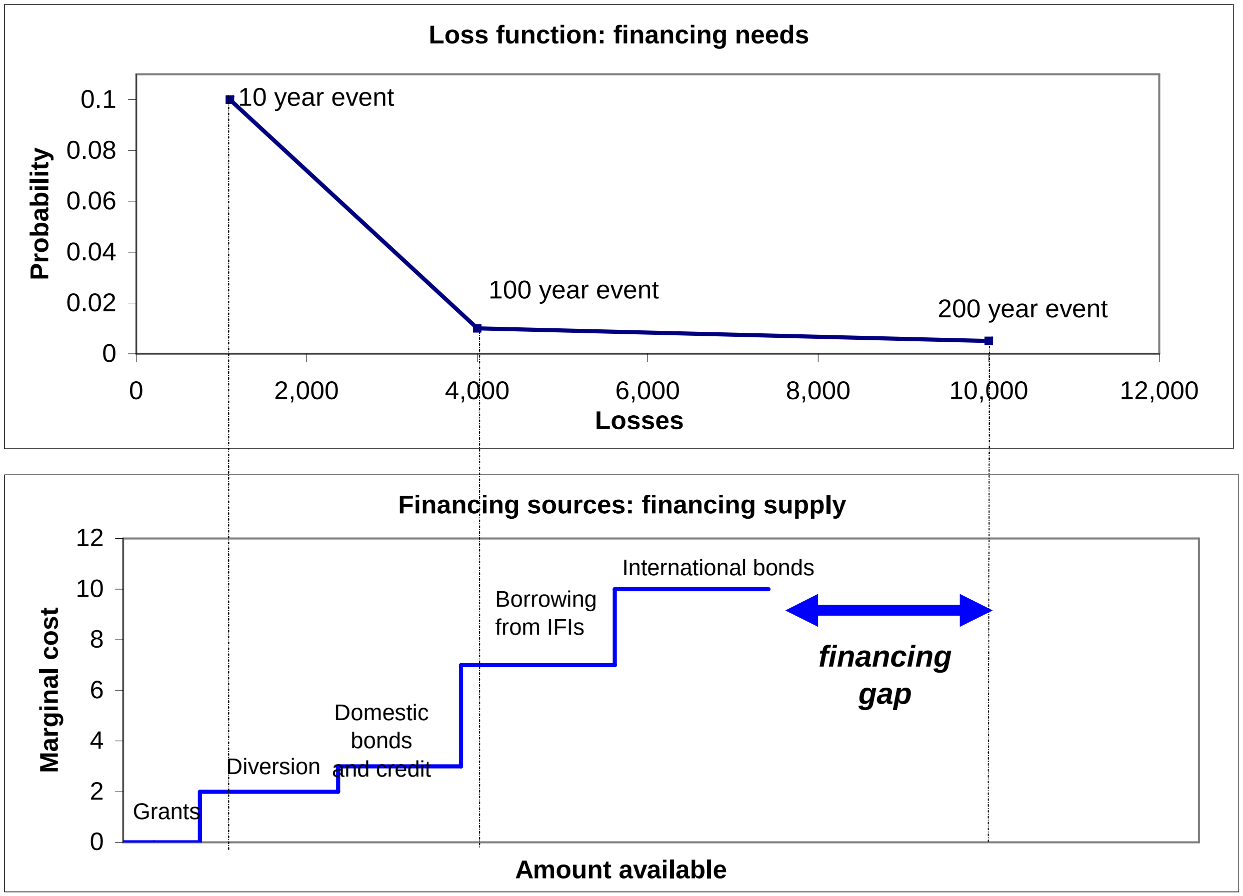
Source: Kohler et al. 2004.

Operationalizing vulnerability and adaptation
Physical vulnerability

Large scale riverine flood events in Bangladesh



Operationalizing vulnerability and adaptation
Financial vulnerability



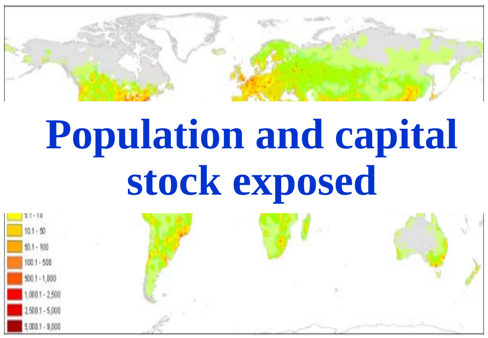
Bangladesh: Inputs, data, models and modules

Based on collaboration in DFID sponsored project on climate risk screening in Bangladesh: ORCHID

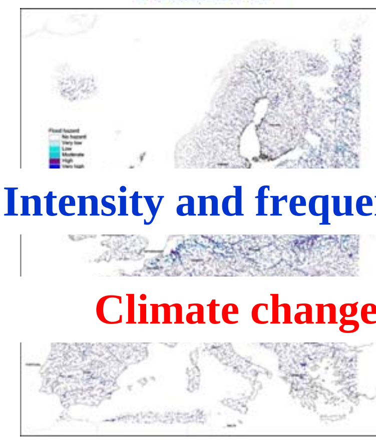
- Institute of Development Studies (IDS), University of Sussex, UK
- CEGIS – Center for Environmental and Geographic Information Services, Bangladesh
- Bangladesh Institute of Development Studies (BIDS), Bangladesh
- School of Development Studies-Overseas Development Group, University of East Anglia, UK
- Tyndall Centre for Climate Research, University of East Anglia, UK
- International Institute of Applied Systems Analysis (IIASA), Austria
- Bangladesh Unnayan Parishad (BUP), Bangladesh
- Bangladesh Centre for Advanced Studies (BCAS), Bangladesh

Module/input data	Source
Mean temperature change, precipitation and change as function of temperature	PRECIS RCM for A2, B1
Max. discharge as function of precipitation	Statistical hydrological model
Flood impacts, Vulnerability	Bangladesh statistics
Flooded area as function of max discharge	Statistical model
Exposure	GGI: GDP, Pop, assets
Losses as function of flooded area	CATSIM extended
Operationalization of vulnerability	CATSIM extended
Economic impacts as function of losses	CATSIM
Risk Management/adaptation	CATSIM

Modelling: risk framework

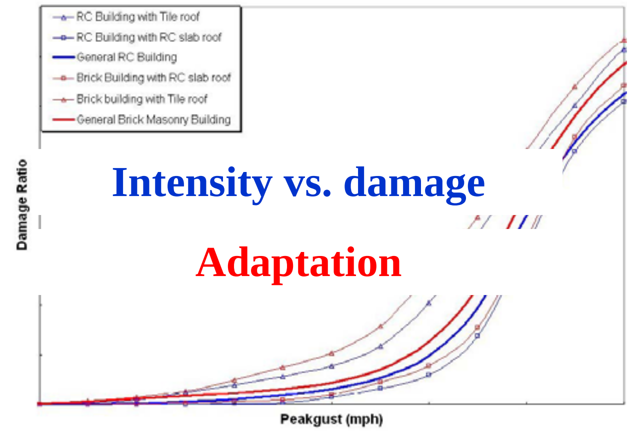


Population and capital stock exposed



Intensity and frequency

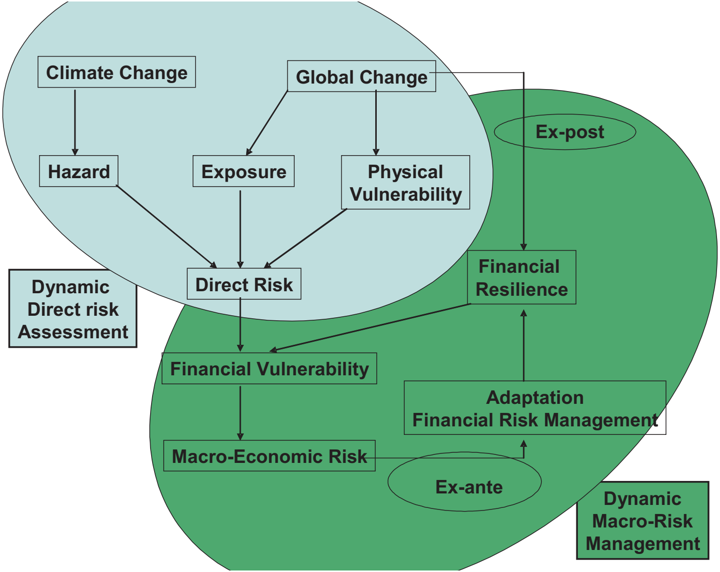
Climate change



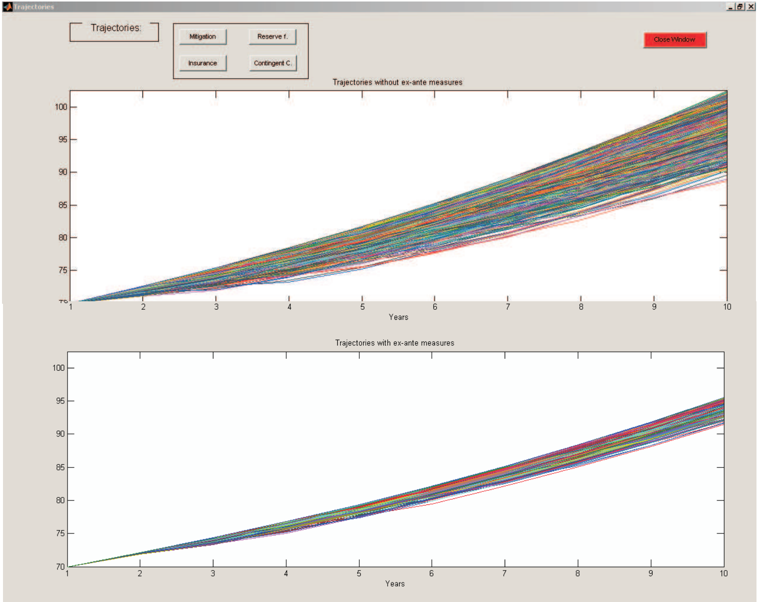
Intensity vs. damage

Adaptation

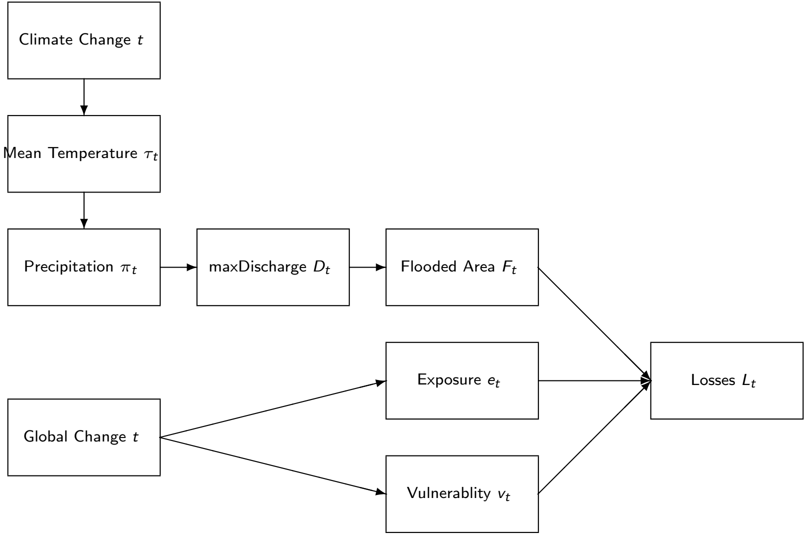
IIASA's CATSIM Model Part I: Direct Risk Assessment



Macro-economic Risk: Short run 2005-2015

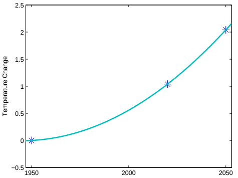


Dynamic Direct Risk Assessment



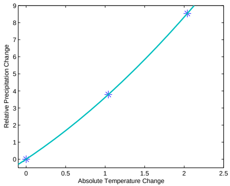
Climate Change

- Temperature Change



$$\tau_t = \tau_{1950} + 0.000185t^2 - 0.718t + 699$$

- Precipitation as function of temperature



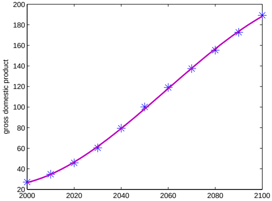
$$\pi_t/\pi_{1950} = 0.542(\tau_t - \tau_{1950})^2 + 3.08(\tau_t - \tau_{1950})$$

- Location/scale of Discharge distributions

$\mu_t = 131978 + 1.366, 8\pi_t/\pi_{1950}, \sigma_t = 0.1751 \cdot \mu_t$

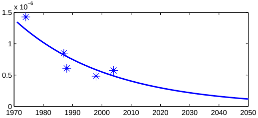
Global Change

- Exposure e_t = gross domestic product



$$e_t = -0.0001364t^3 + 0.08425t^2 - 1732t + 1186600$$

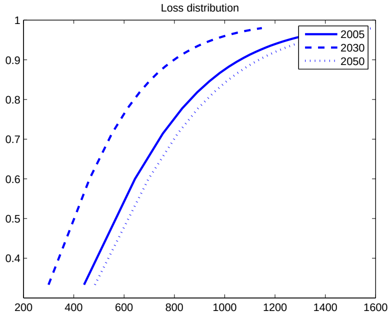
- Vulnerability v_t = damage per Exposure and Flooded Area



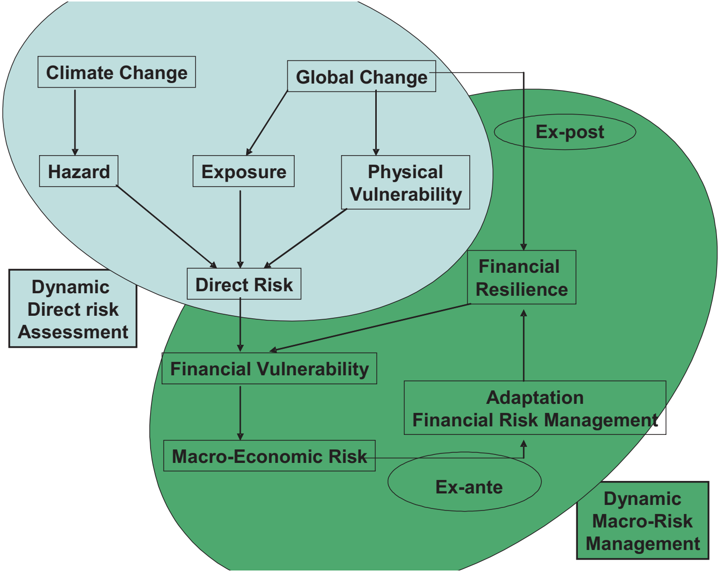
$$v_t = 3.8 * 10^{20} \exp(-0.0309t)$$

Estimated future loss distributions

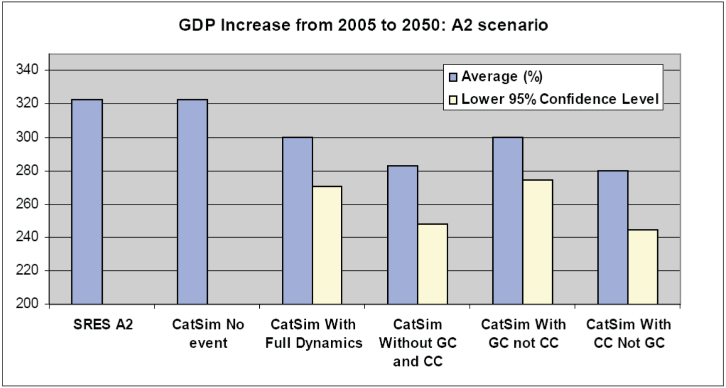
Let G_t be the loss distribution $G_t(\ell) = P\{L_t \leq \ell\}$. We estimated this distributions for the years 2005-2050.



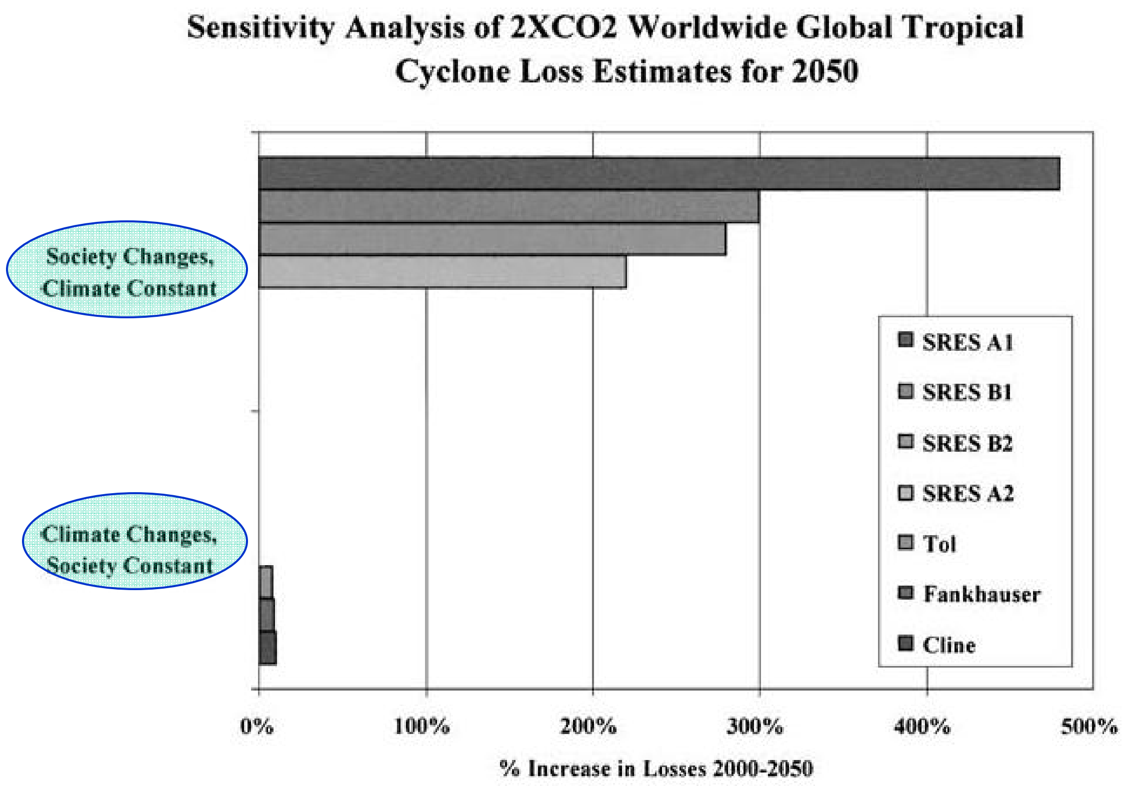
IIASA's CATSIM Model Part II: Macro-economic Risk



Results: GDP Development Comparisons 2005-2050



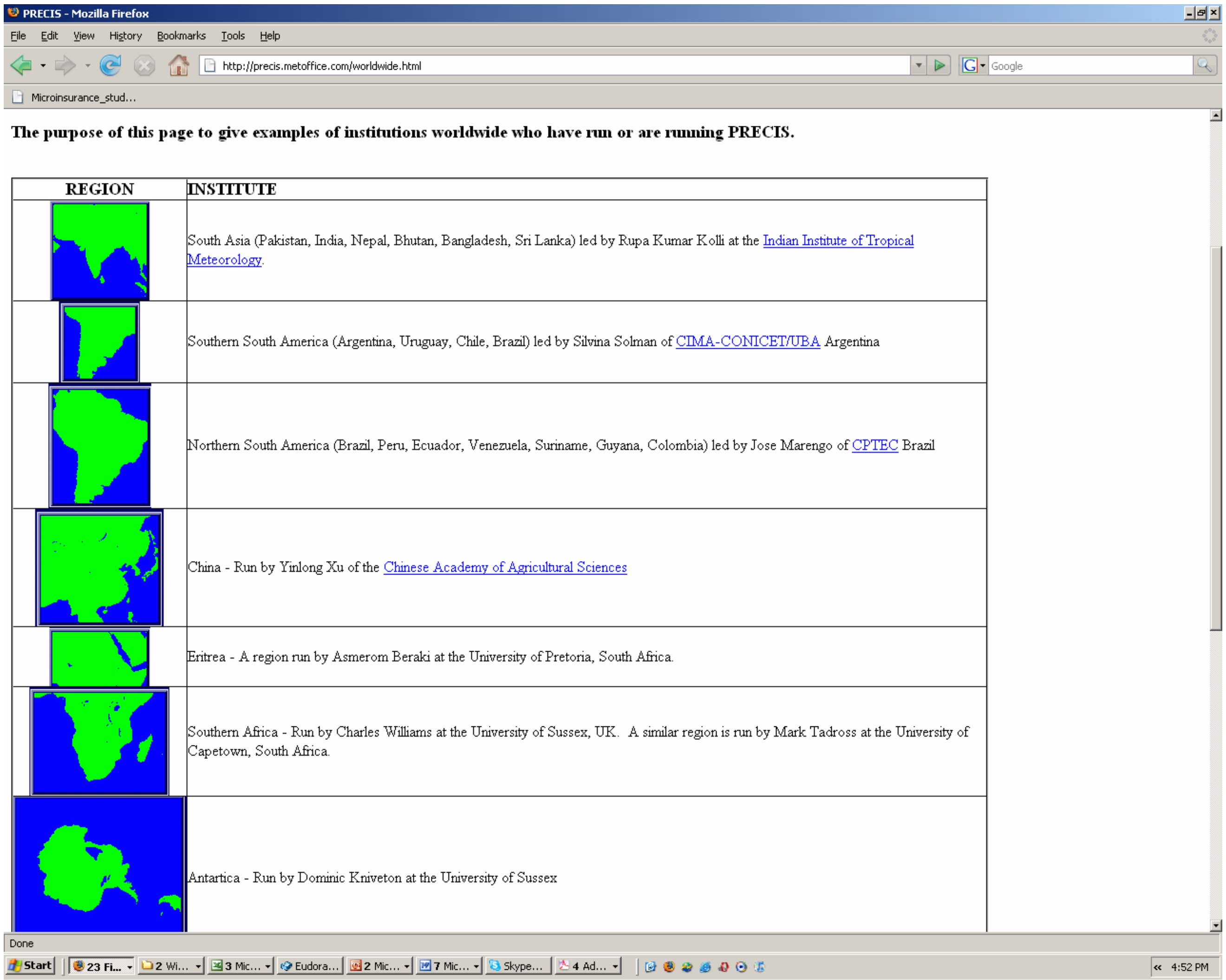
Findings in IAM studies



Disaster losses in integrated assessment models

Source: Pielke Jr. and Sarewitz, 2005

Availability of high resolution GCM information



The purpose of this page to give examples of institutions worldwide who have run or are running PRECIS.

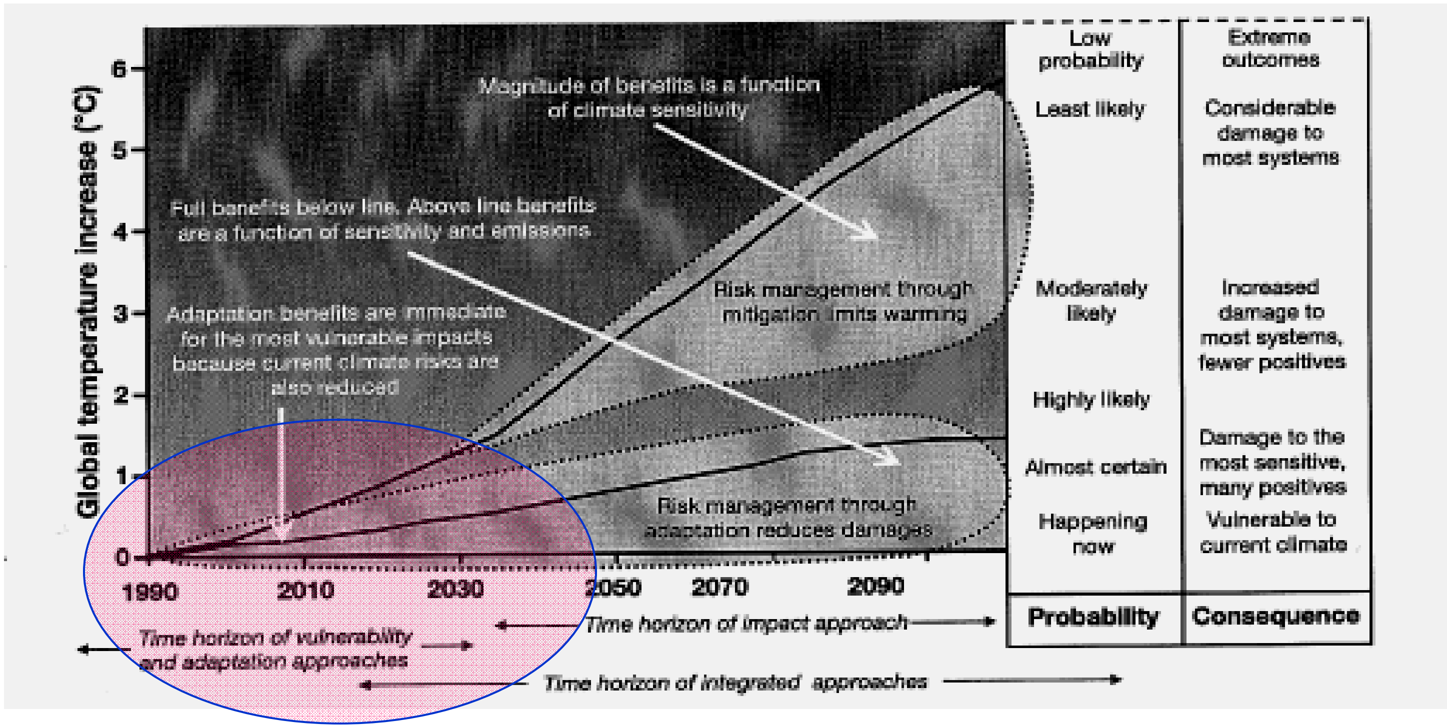
REGION	INSTITUTE
	South Asia (Pakistan, India, Nepal, Bhutan, Bangladesh, Sri Lanka) led by Rupa Kumar Kolli at the Indian Institute of Tropical Meteorology.
	Southern South America (Argentina, Uruguay, Chile, Brazil) led by Silvina Solman of CIMA-CONICET/UBA Argentina
	Northern South America (Brazil, Peru, Ecuador, Venezuela, Suriname, Guyana, Colombia) led by Jose Marengo of CPTEC Brazil
	China - Run by Yinlong Xu of the Chinese Academy of Agricultural Sciences
	Eritrea - A region run by Asmerom Beraki at the University of Pretoria, South Africa.
	Southern Africa - Run by Charles Williams at the University of Sussex, UK. A similar region is run by Mark Tadross at the University of Capetown, South Africa.
	Antartica - Run by Dominic Kniveton at the University of Sussex

Discussion
Relevance of adaptation research for 2 decisions

- **Mitigation decision: Benefits to mitigation (see Stern, 2007; IPCC, 2007)**
  - Cost of inaction of 5-20% losses GDP/a can be avoided
  - With mitigation cost of 1% GDP/a
  - Global, public sector decision problem: parties to UNFCCC

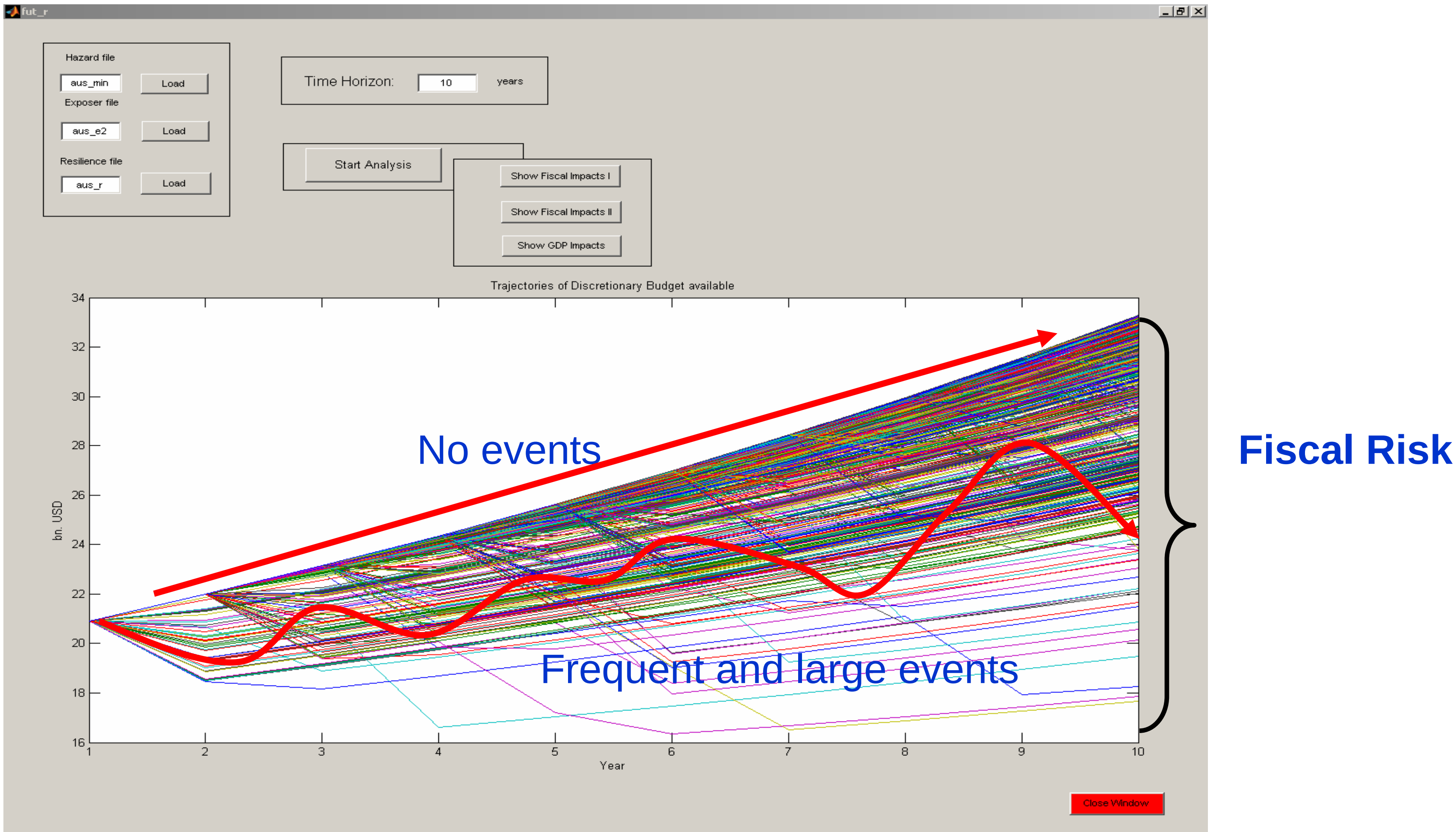
- **Adaptation decision: Benefits to adaptation**
  - Where and who?
  - How much?
  - When?
  - Rather shorter term in line with decision problem
    - Political cycle: 4 a
    - Infrastructure investment decisions < 30-50 a

Discussion
Risk management framework and adaptation and mitigation



Source: IPCC AR4, WG II (Carter, Jones et al., 2007)

Discussion
Decision support



Trajectories of governments' variable (discretionary) budget for a time horizon of 10 years

Conclusions

- Dynamic framework to assess future risks
- Country-level analysis responds to decision-problem of national-level decisonmakers
- Global changes, e.g. reduction of physical vulnerability, seems more important for Bangladesh than threat of climate change, e.g. increase in rainfall intensity
- Yet, differences between global and climate change not as pronounced as with top-down IAM
- Spatially resolved climate and climate change information increasingly available

Problems

- RCM has focus on mean changes, no variability
- Country-level disaster risk analysis more applicable to smaller countries or countries with simple topography
- Uncertainties large, not always possible to quantify
- Few data points on disaster impacts and vulnerability
- Uncertainty in tail estimation in general – extrapolation beyond the maximal observed value
- High residual (unexplained) variances

Next steps

- Journal paper
- Presentation at UN/World Bank Expert Workshop: *Integrating Climate Change Information into Disaster Risk Analysis, Spring 2008*