



TECHNOLOGY FOR ADAPTATION TO CLIMATE CHANGE IN COASTAL ZONES

Richard J.T. Klein^{1,2}

1. Potsdam Institute for Climate Impact Research, Germany
2. Stockholm Environment Institute–Oxford, UK

UNFCCC Seminar on the Development and Transfer of
Environmentally Sound Technologies for Adaptation to Climate Change

Tobago, 14–16 June 2005



OUTLINE

- Potential impacts of climate change on coastal zones
- Examples of technologies for adaptation
- Integrated coastal zone management



NON-CLIMATE STRESSES ON COASTS (1)

- 37% of the world's population lives within 100 km from the coastline.
- In many places, population growth in coastal zones is double that of national average population growth.
- 23 cities are expected to have more than 10 million inhabitants by 2015; 18 of these are coastal.
- With the exception of Tokyo, New York, Los Angeles and Osaka, all coastal megacities are in developing countries.



NON-CLIMATE STRESSES ON COASTS (2)

- Natural coastal systems provide many goods and services that support a range of socio-economic activities.
- Important activities include tourism and recreation, fisheries and aquaculture, mining, industry, transportation and infrastructure development.
- Overexploitation of one particular good or service can inhibit the provision of goods or services that are valued less financially or which enable the system to self-regulate.



FIRST-ORDER EFFECTS OF CLIMATE CHANGE

Climate factor	Direction	Biogeophysical effects
Global sea level	Positive	Inundation and displacement of wetlands and lowlands; coastal erosion; increased storm flooding and damage; salinisation; rising water tables; impeded drainage
Seawater temperature	Positive	Increased coral bleaching; increased algal blooms; migration of coastal species to higher latitudes; decreased incidence of sea ice at higher latitudes
Precipitation intensity	Positive	Increased flood risk in coastal lowlands



FIRST-ORDER EFFECTS OF CLIMATE CHANGE

Climate factor	Direction	Biogeophysical effects
Wave climate	Unknown	Changed cross-shore and longshore sediment transport, and hence patterns of erosion and accretion
Storm frequency	Regional variation	Changed occurrence of storm flooding and damage
River runoff	Regional variation	Changed sediment supply from rivers to the coast
Atmospheric CO ₂	Positive	Increased productivity in coastal ecosystems





POTENTIAL IMPACTS OF SEA-LEVEL RISE

Sector	Biogeophysical effect					
	Flood frequency	Erosion	Inundation	Rising water tables	Saltwater intrusion	Biological effects
Water resources			✓	✓	✓	✓
Agriculture	✓		✓	✓	✓	
Human health	✓		✓			✓
Fisheries	✓	✓	✓		✓	✓
Tourism	✓	✓	✓			✓
Human settlements	✓	✓	✓	✓		

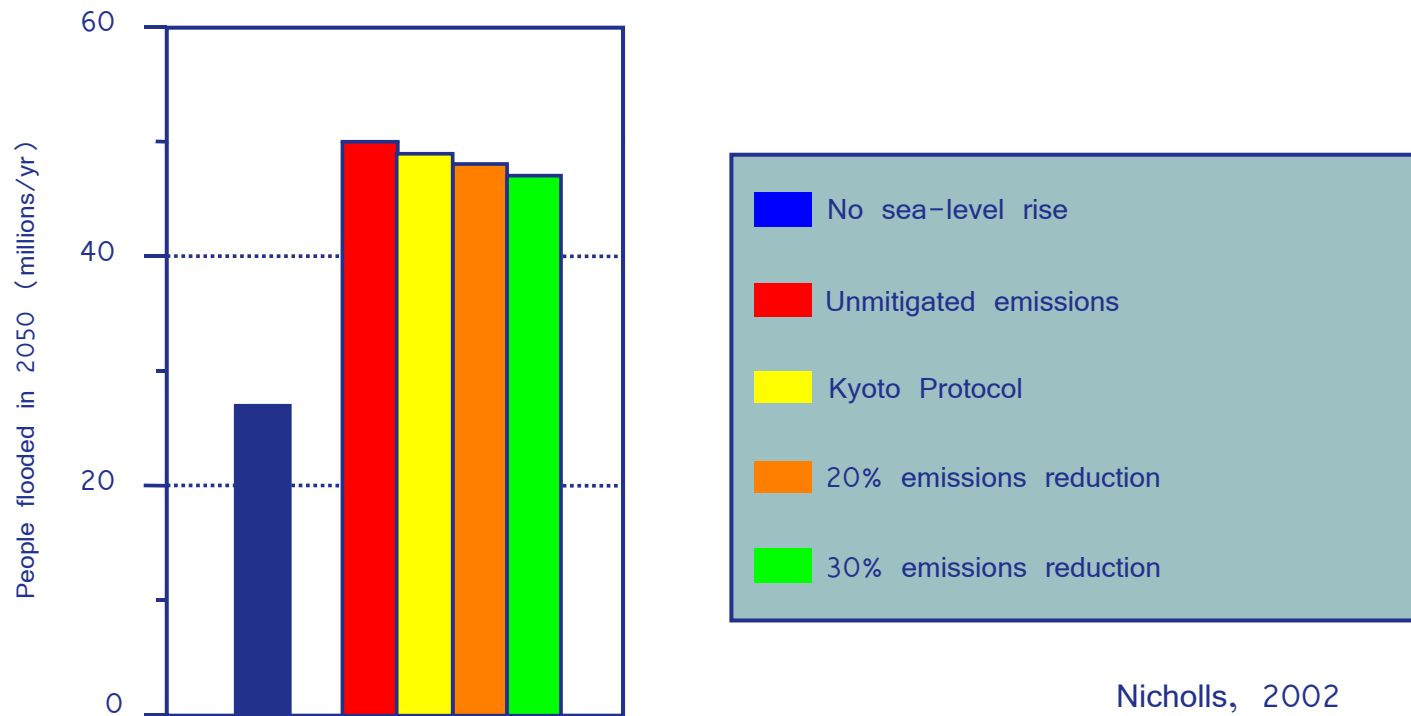


IMPACTS TYPICALLY ASSESSED

Sector	Biogeophysical effect					Biological effects
	Flood frequency	Erosion	Inundation	Rising water tables	Saltwater intrusion	
Water resources			✓	✓	✓	✓
Agriculture	✓		✓	✓	✓	
Human health	✓		✓			✓
Fisheries	✓	✓	✓		✓	✓
Tourism	✓	✓	✓			✓
Human settlements	✓	✓	✓	✓		



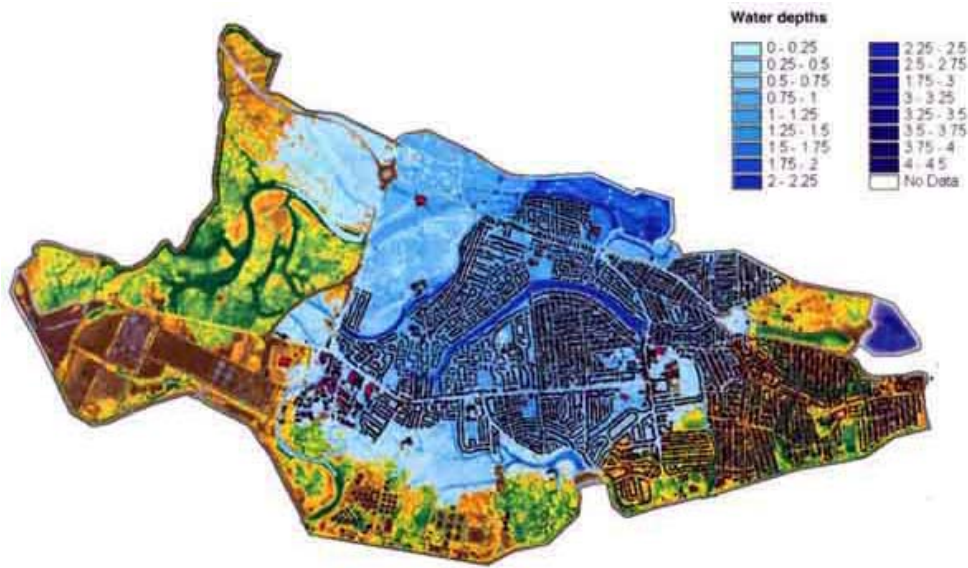
PEOPLE AT RISK OF FLOODING



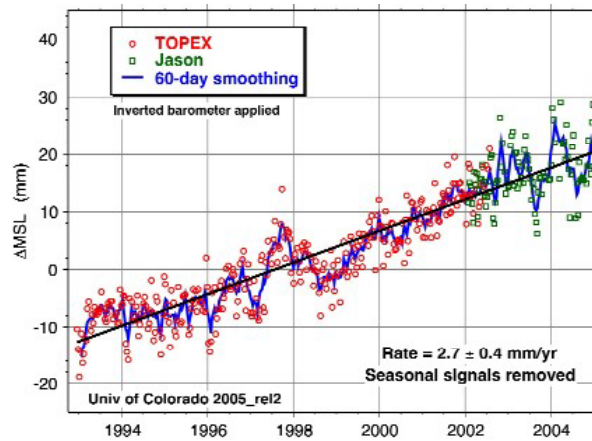
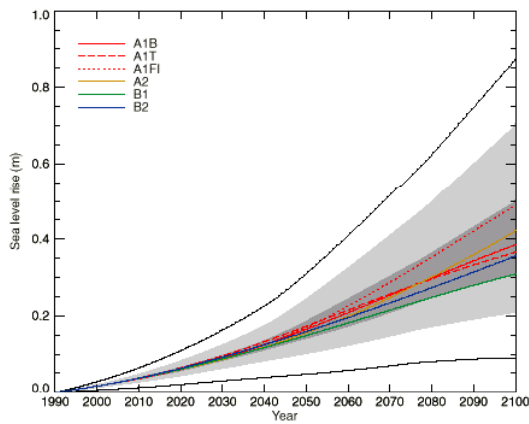


INFORMATION AND AWARENESS

- Coastal system description (maps, tide gauges, buoys, remote sensing, surveys).
- Climate impact assessment (scenarios, models, place-based analysis).
- Awareness raising (printed information, audio-visual media, interactive tools).



Self-Help Advice
Storm Surges



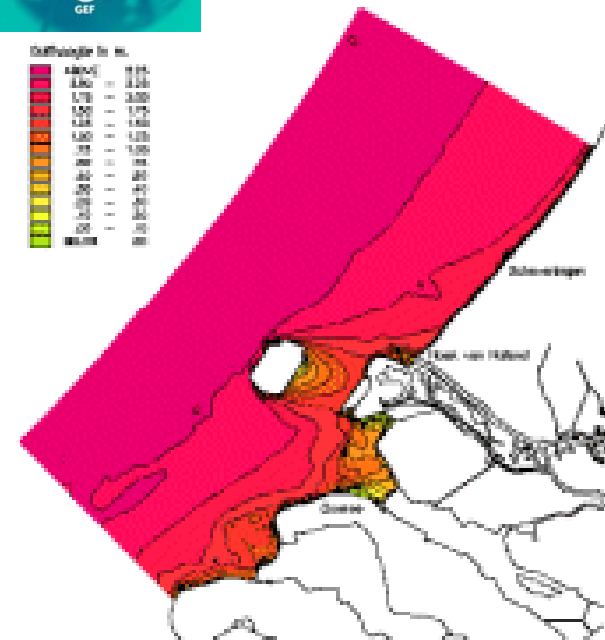
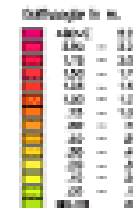
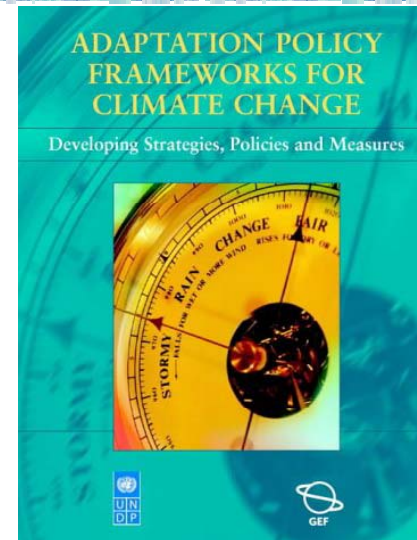


PLANNING AND DESIGN

- Simulation tools (sediment budget models, economic models).
- Decision tools (cost-benefit analysis, cost-effectiveness analysis, multi-criteria analysis).
- Integration tools and frameworks (*e.g.*, APF, NAPAs).
- Cross-cutting technology: geographical information systems.



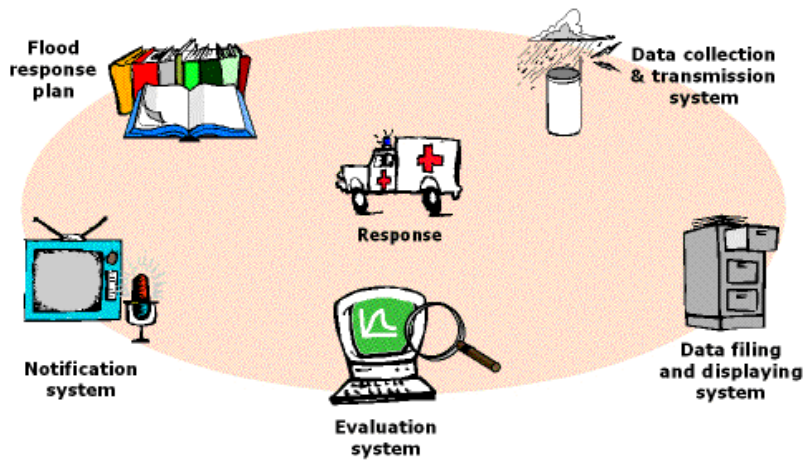
FLOOD PROOFING MATRIX		FLOOD PROOFING MEASURES												
		Elevation on Foundation Walls	Elevation on Piers	Elevation on Posts or Columns	Elevation on Piles	Relocation	Floodwalls and Levees	Floodwalls and Levees with Closures	Dry Flood Proofing	Wet Flood Proofing				
FLOODING CHARACTERISTICS	Flood Depth													
	Shallow (less than 3 feet)													
	Moderate (3 to 6 feet)							N/A	N/A					
	Deep (greater than 6 feet)						N/A	N/A	N/A					
	Flood Velocity													
	Slow (less than 3 fps)													
	Moderate (3 to 5 fps)							N/A	N/A					
	Fast (greater than 5 fps)	N/A ¹	N/A ¹				N/A ¹	N/A ¹	N/A	N/A				
	Flash Flooding													
	Yes (less than 1 hour)	N/A ¹						N/A ²	N/A ²	N/A ²				
No														
Ice and Debris Flow														
Yes	N/A						N/A	N/A	N/A					
No														
SITE CHARACTERISTICS	Site Location													
	Coastal Floodplain	N/A					N/A	N/A	N/A	N/A				
	Riverine Floodplain													
	Soil Type													
Permeable						N/A ³	N/A ³	N/A						
Impermeable														
BUILDING CHARACTERISTICS	Building Foundation													
	Slab on Grade													
	Crawl Space													
	Basement		N/A	N/A	N/A			N/A	N/A ⁴					
	Building Construction													
	Concrete or Masonry				N/A ⁵									
	Wood and Others				N/A ⁵			N/A	N/A ⁴					
	Building Condition													
Excellent to Good														
Fair to Poor	N/A	N/A	N/A	N/A	N/A			N/A	N/A					





IMPLEMENTATION

- Protect: decrease probability of occurrence (*e.g.*, dikes, seawalls, beach nourishment).
- Retreat: limit potential effects (*e.g.*, establishing set-back zones, relocating threatened buildings).
- Accommodate: increase society's ability to cope with the effects (*e.g.*, emergency plans, insurance, modification of land use and agricultural practices).



**NATIONAL
FLOOD
INSURANCE
PROGRAM**



MONITORING AND EVALUATION

- Similar technologies as for coastal system description, in combination with an evaluation framework (requires development and agreement on indicators and criteria).





INTEGRATED COASTAL ZONE MANAGEMENT

- Traditional approaches to coastal management have tended to focus on single issues.
- In view of the increasing potential for resource use conflicts, a policy process is needed to strike a balance between sectoral interests, both in the short and the long term.
- Adaptation to climate change requires close co-ordination with and participation from stakeholders.



THANK YOU FOR YOUR ATTENTION!