

Vulnerability, security risks and resilience of sea-level change in coastal communities

Jürgen Scheffran

Research Group Climate Change and Security

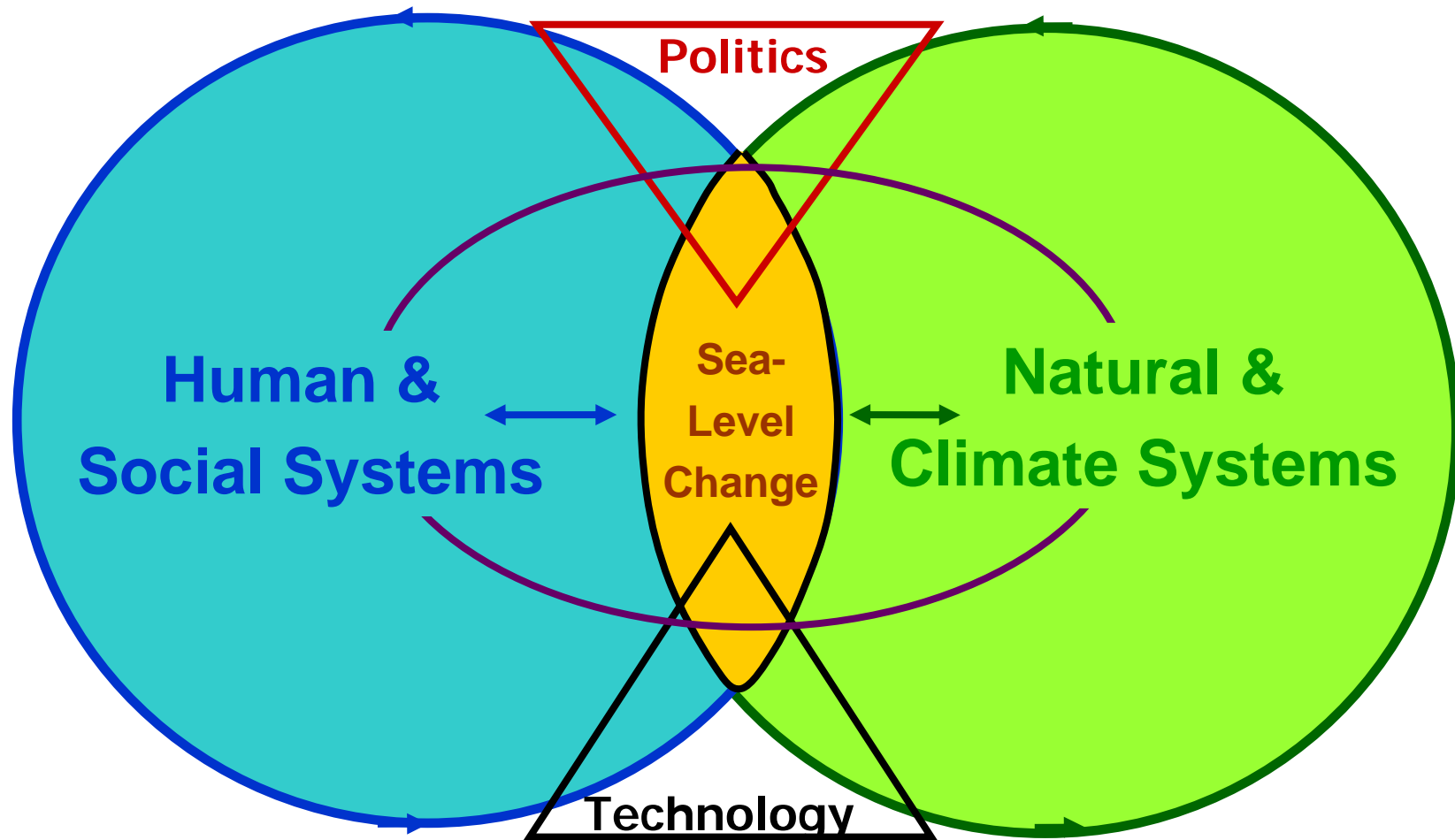
Institute of Geography, KlimaCampus, University of Hamburg

Transatlantic Solutions to Sea Level Rise Adaptation:

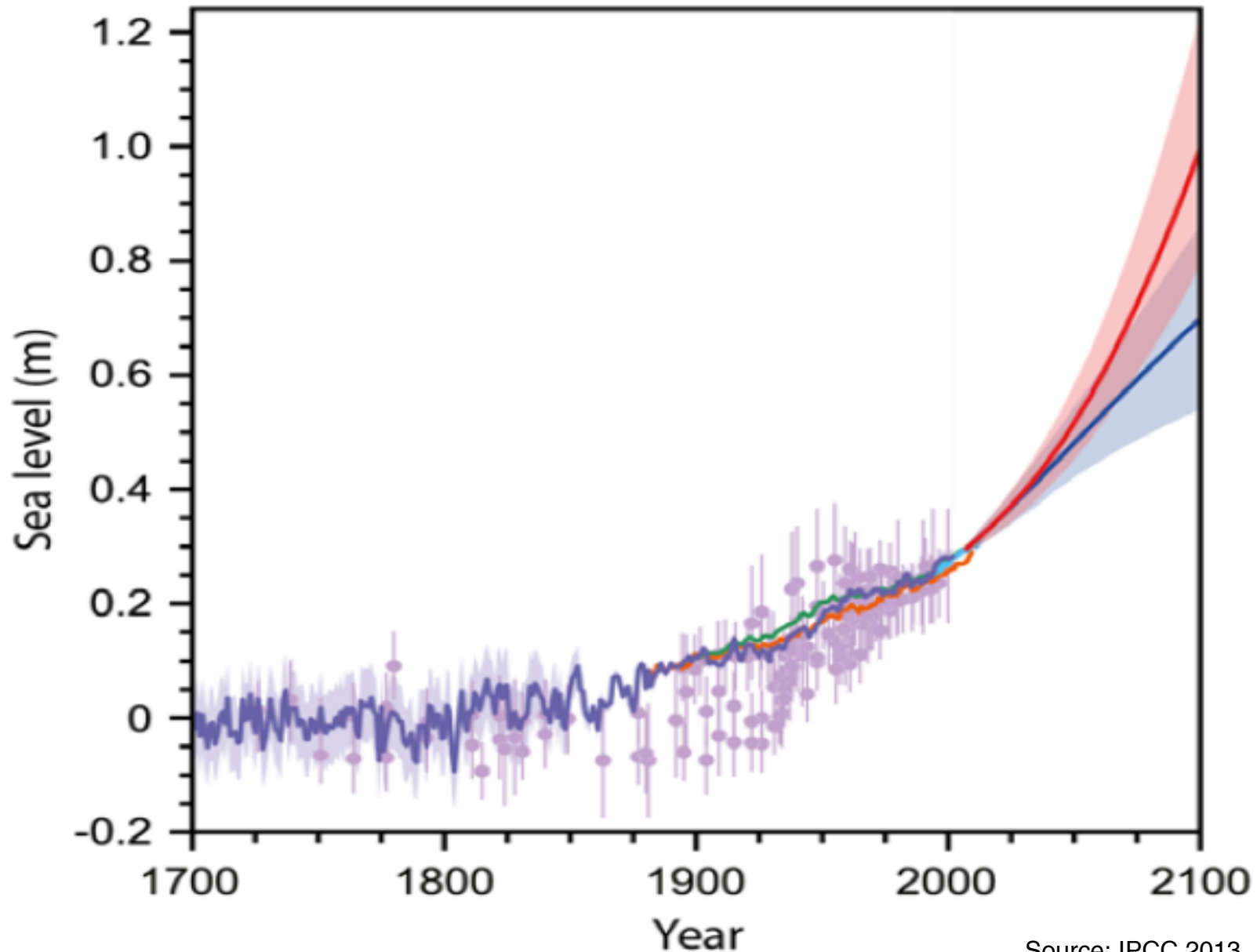
Moving Beyond the Threat

Old Dominion University, Norfolk, October 30-31, 2013

Sea-Level Change in Human-Nature Interaction

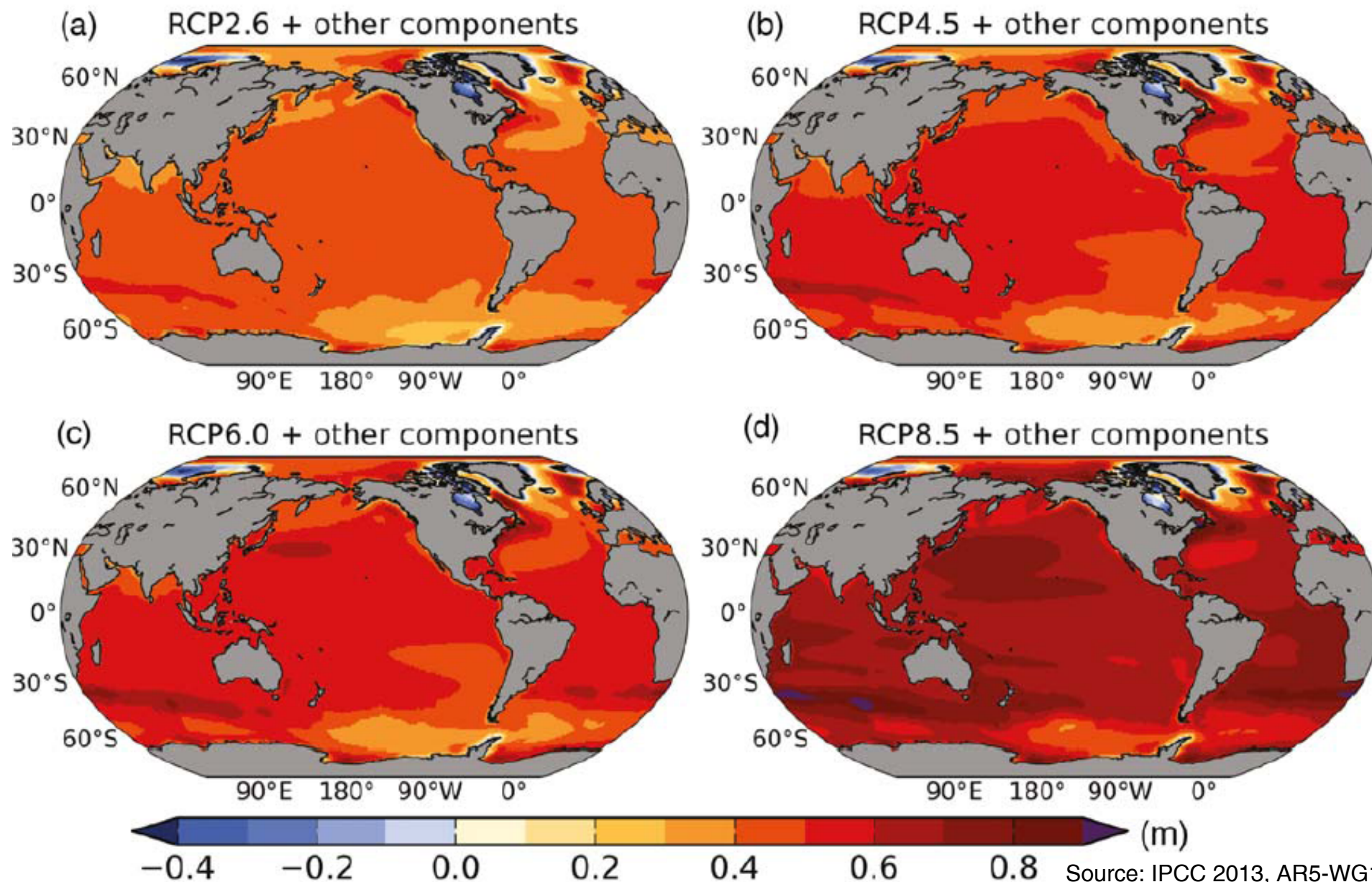


Past data and future projections of global-mean sea level rise for RCP2.6 (blue) and RCP8.5 (red) scenarios

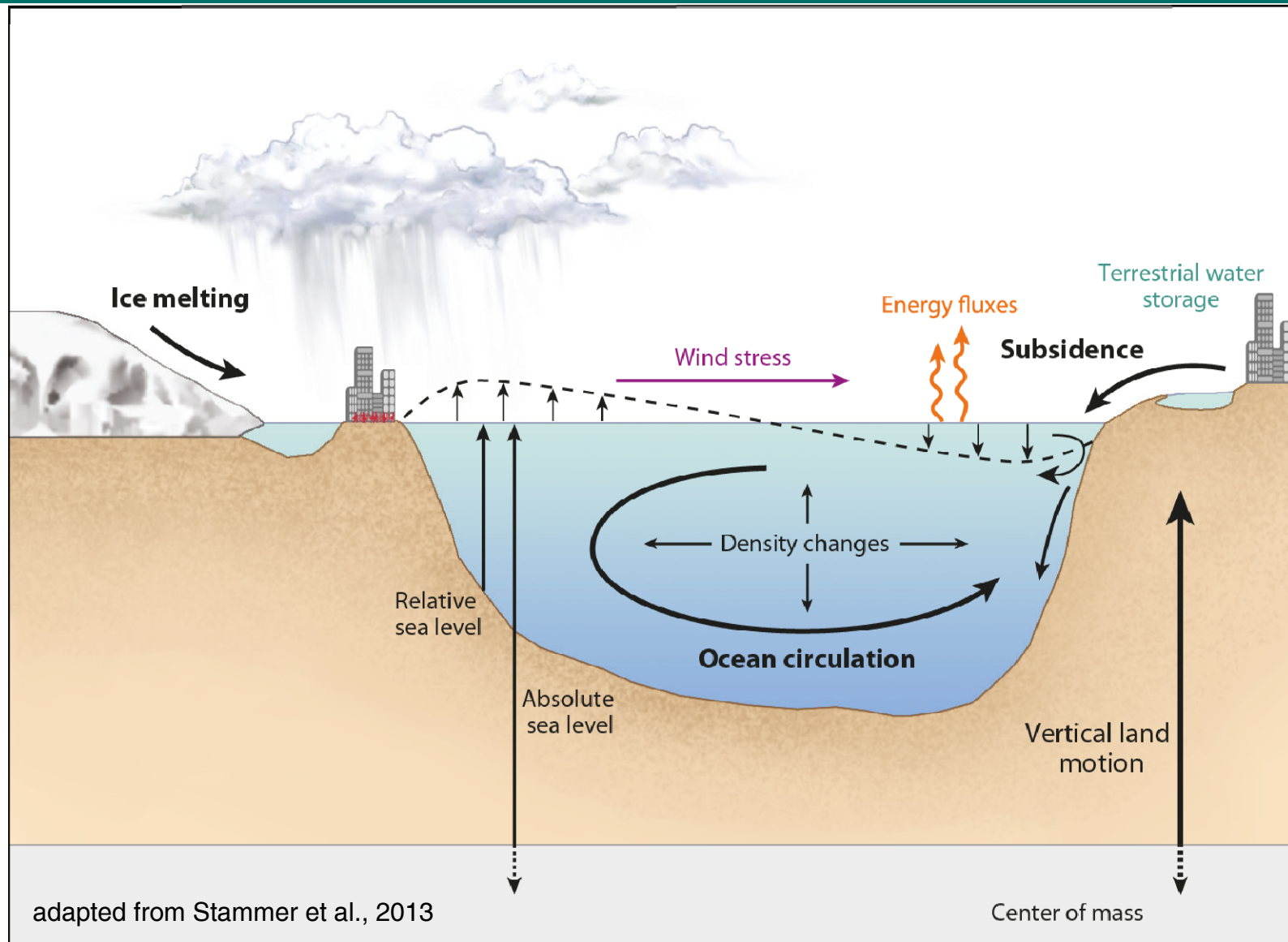


Source: IPCC 2013, AR5-WG1

Ensemble mean net regional sea level change from 21 CMIP5 models for different RCP scenarios between 1986–2005 and 2081–2100



Processes influencing regional sea level

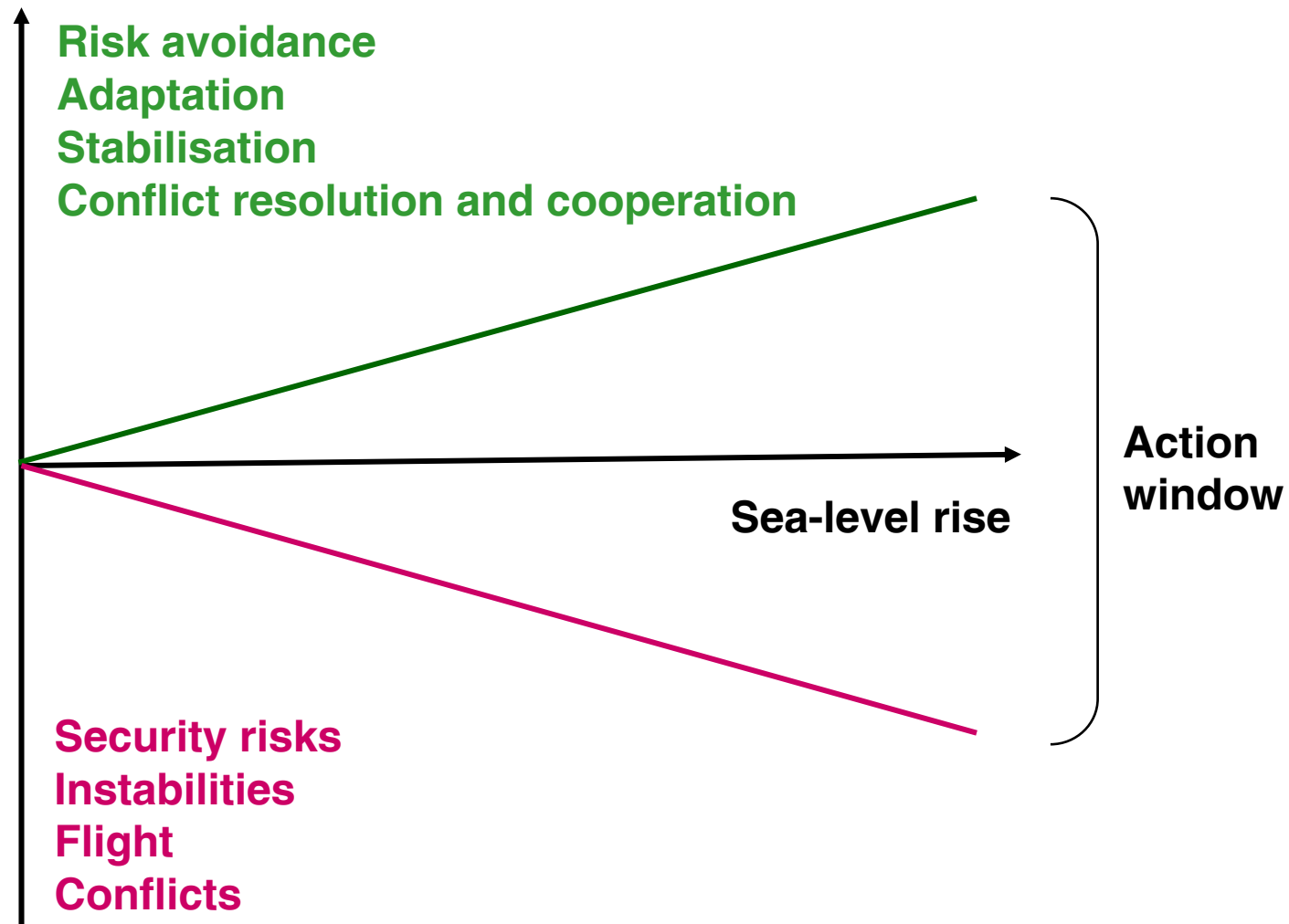


Possible consequences of sea-level change

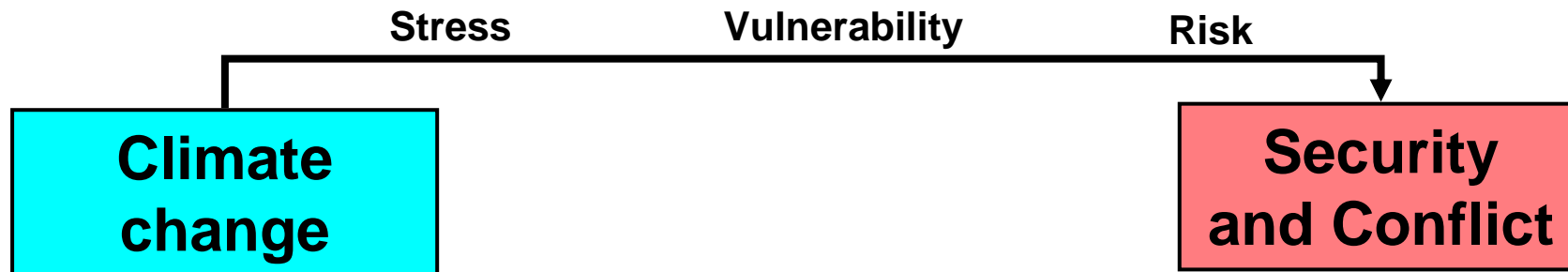
- Coastal flooding and erosion
- Intrusion of saline sea water into fresh water reservoirs
- Impact on coastal wetlands and river deltas
- Loss of agricultural land
- Threat to big coastal cities hosting a large fraction of the world's population
- Direct impact on livelihood and human security of coastal populations
- Effect on infrastructures vital for society

Conflict or cooperation

How will human beings and societies respond?



Interaction between climate change, security and conflict



Hexagon Series on Human and Environmental
Security and Peace VOL 8



Jürgen Scheffran · Michael Brzoska
Hans Günter Brauch · Peter Michael Link
Janpeter Schilling *Editors*



Climate Change, Human Security and Violent Conflict

Challenges for Societal Stability

 Springer

Science

18 May 2012 | \$10



CLIMATE CHANGE AND VIOLENT CONFLICT

Jürgen Scheffran,^{1*} Michael Brzoska,² Jasmin Kominek,^{1,3} P. Michael Link,^{1,4} Janpeter Schilling^{1,5}

Security and conflict issues of sea-level rise

- Impact on vital ecosystems, species and biodiversity (flooding, erosion, wetlands, mangroves, river deltas, coral reefs)
- Risk to socio-economic infrastructures and resources along the coast (water, energy, agriculture, urban, transport, tourism, property)
- Threat to densely populated urban regions
- Loss of human health and life (human security)
- Impact on coastal military installations and transportation routes

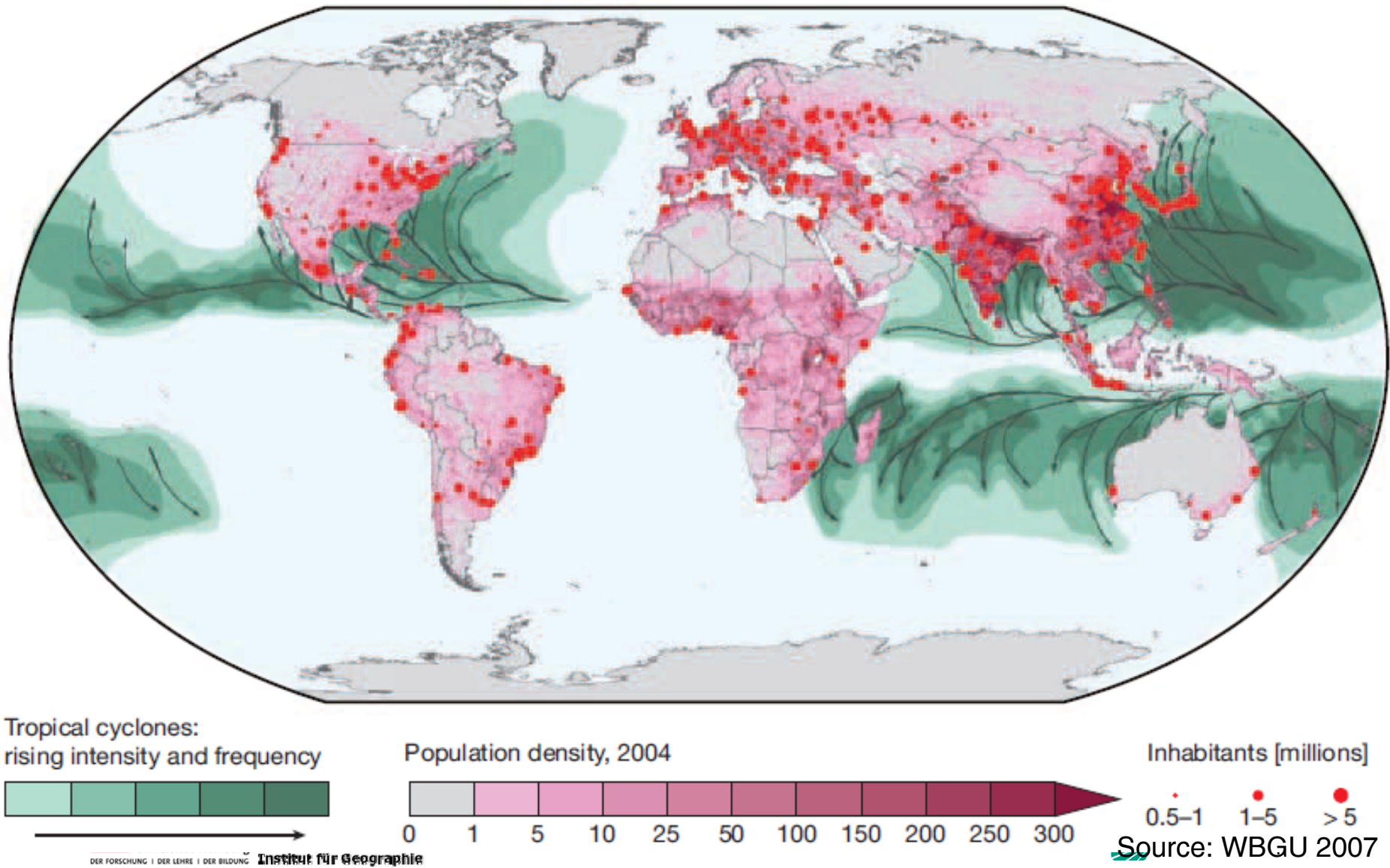
Security and conflict issues of sea-level rise

- Human migration, displacement and relocation
- Struggle on adaptation costs and consequences
- National sovereignty, borders and coastal economic zones
- Violent conflicts induced by sea-level risks and threats
- Foreign interventions (rescue, disaster management, military force)
- Combination effects, tipping points and risk cascades

Vulnerability of river deltas



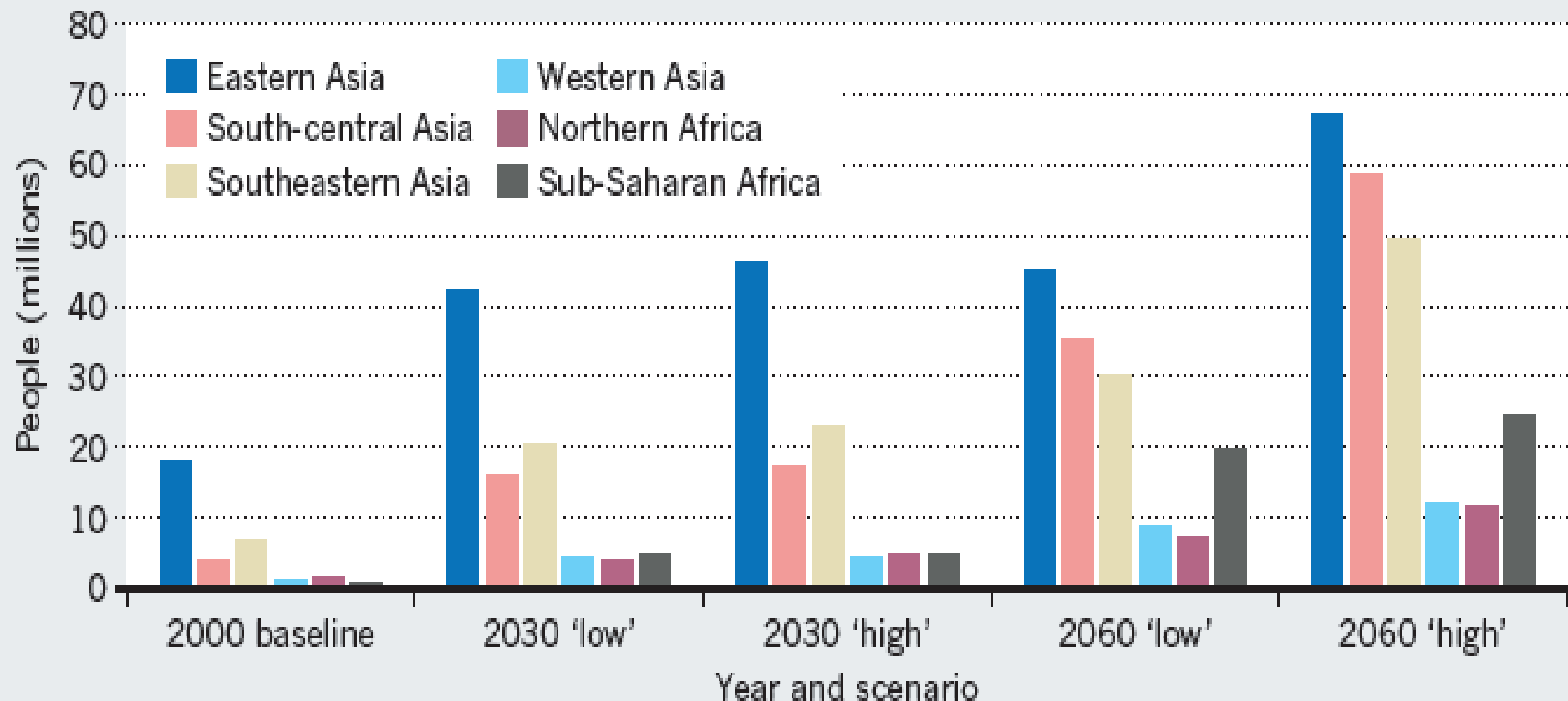
Tropical cyclone risk to urban agglomerations



Urban coastal flood risk

URBAN COASTAL FLOOD RISK

The number of people living in cities that are at risk of coastal flooding is set to increase dramatically over the coming decades in both 'high' and 'low' scenarios of economic growth and governance*.

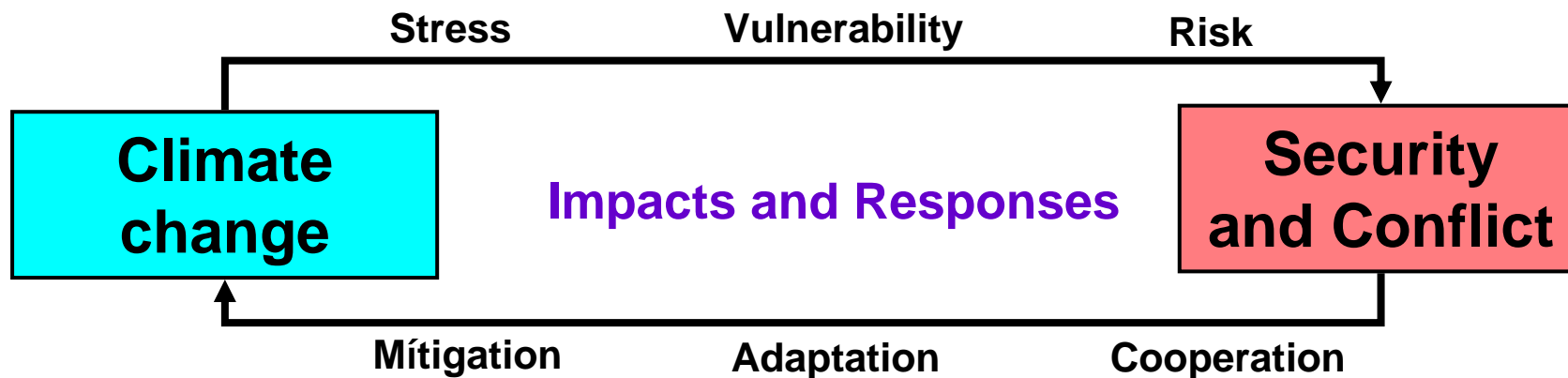


*Low scenario = high economic growth and inclusive governance; high scenario = low global economic growth and fragmented governance

Vulnerability, risk and human security

- Vulnerability: exposition, sensitivity, adaptive capacity
- Risk: extent of damage and probability of occurrence of an event
- Human security: focus on fear, danger, risks, and threats to humans (1994 Human Development Report)
- UN Commission on Human Security 2003: “shielding people from acute threats and empowering people to take charge of their own lives.”.
- UN general secretary: “human security encompasses freedom from fear, freedom from want and freedom to live in dignity”(UN CHS 2010)
- Specific or broad understanding?
- Vague and controversial concept?
- Threshold of threats?
- Social and political influences and constructs?
- How do humans and society react?

Interaction between climate change, security and conflict



Adaptation options and needs

- Vulnerability depends on regional adaptive capacity.
- Adaptive capacity necessary to limit negative consequences

Responses: Adapt to change; protection; damage limitation and disaster management; conflict resolution

Adaptation policy must be:

- Based on valid data about ongoing processes
- Depending on the awareness of action needed by the governments
- Influenced by governance structures, power relations, financial assets and people's values and understandings
- Framed by the people's awareness and perception of hazards

→ Analyse community vulnerability and adaptation for regional hotspots

The concept of social resilience

Resilient communities: cope with stress and retain qualitative structure.

- Capacity to resist shocks and surprises and, if damaged, to rebuild.
- Whether resilience can be maintained depends on the strength and size of change, and the relative capacity of the community to cope with change.
- In a resilient social environment, social actors are able to cope with and resist disturbances caused by environmental change in a dynamic and flexible way that preserves, rebuilds, or transforms their livelihood.
- Concepts of resilience can strengthen the social capability of people in their creative and collective efforts to handle the problems associated with climate change.
- Resilience strategies include building of networks, cultivation of diversity and maintenance of flexibility.
- Framed by people's perception and awareness of hazards
- Shaped by institutions and governance structures

Sea-level rise as social challenge in human-environment interaction

Perspective from integrative geography:

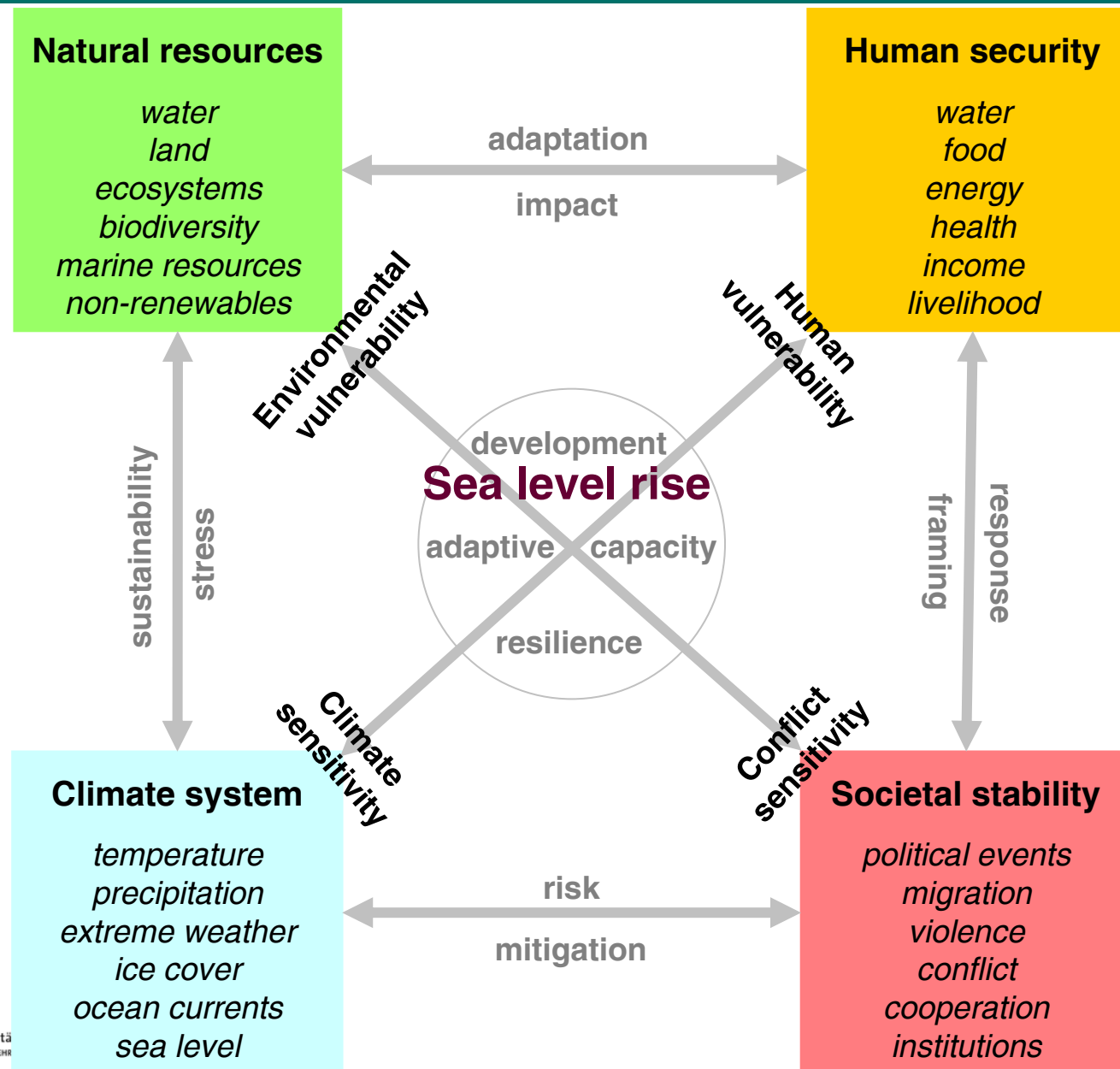
- local and regional characteristics of space
- technical measures that additionally change or shape the topography
- economic and financial possibilities of a given society to react to challenges from SLR
- social structure and differences
- demographic patterns, changes and shifts (including migration)
- institutional boundary conditions and governance mechanisms

→ sustainable balance between natural and social factors and boundary conditions (climate societies)

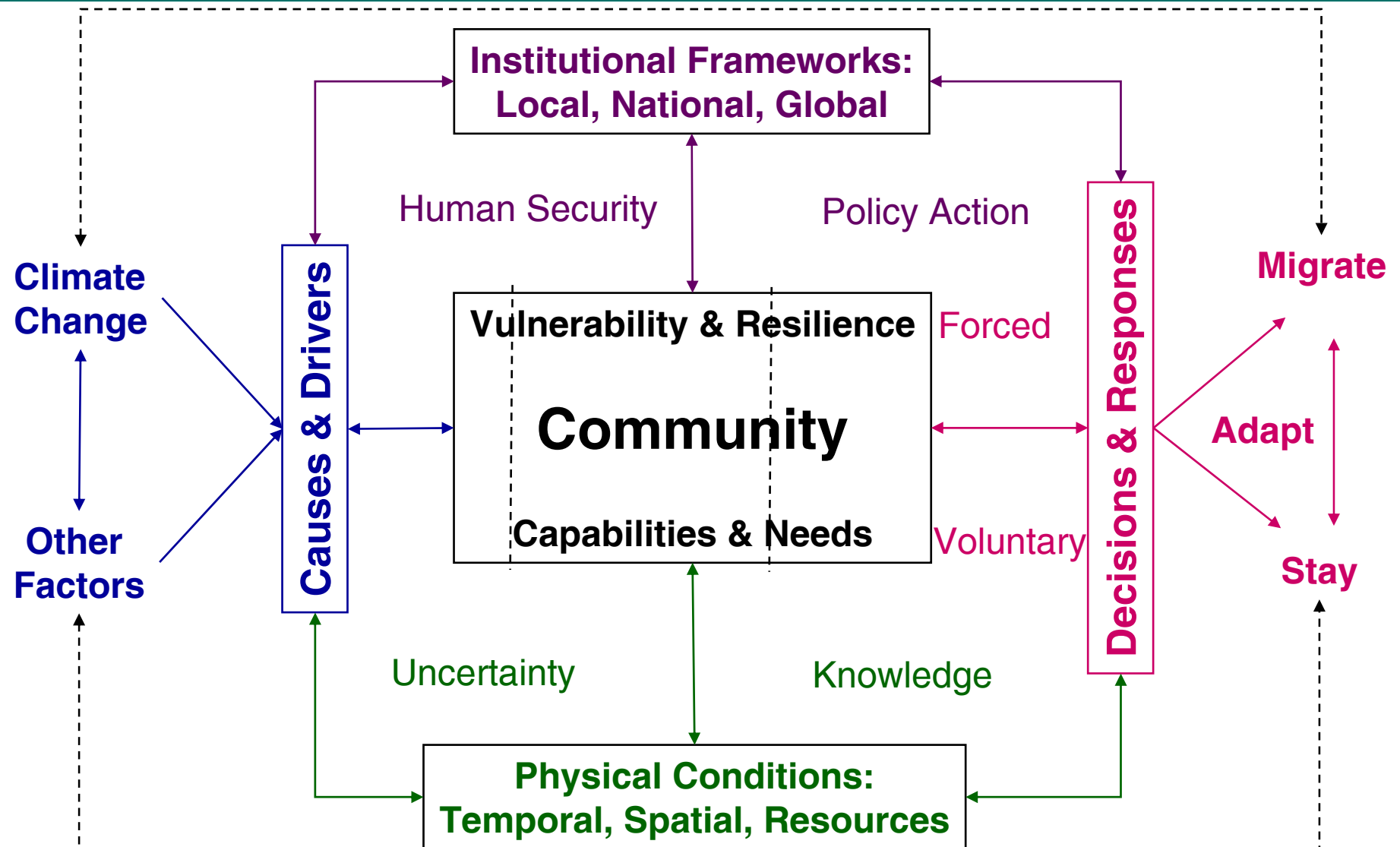
→ integrated framework of climate-society interaction

Complexity of climate-society interaction

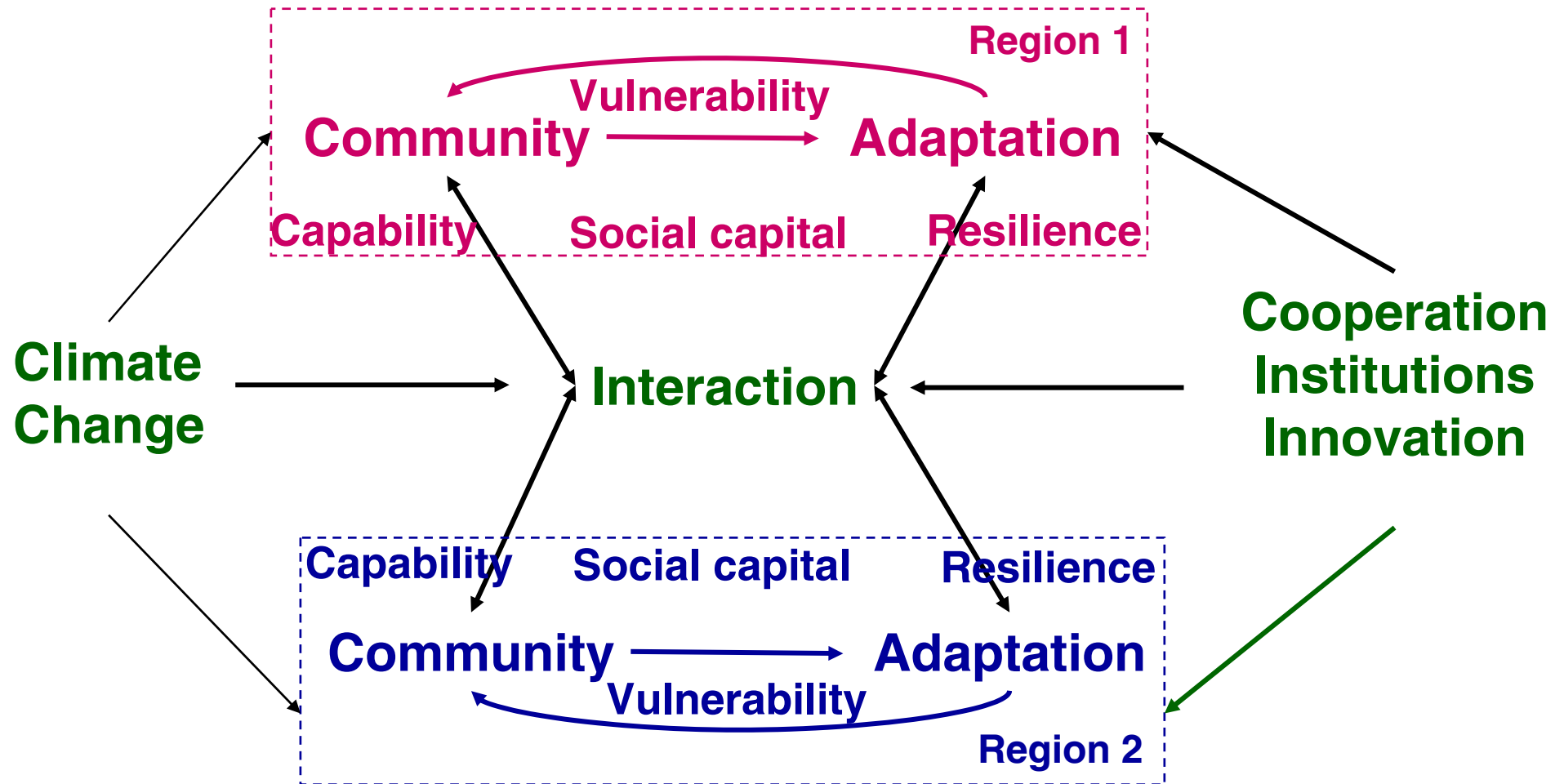
Source: Scheffran et al, Climate Change and Violent Conflict, Science, 18 May 2012



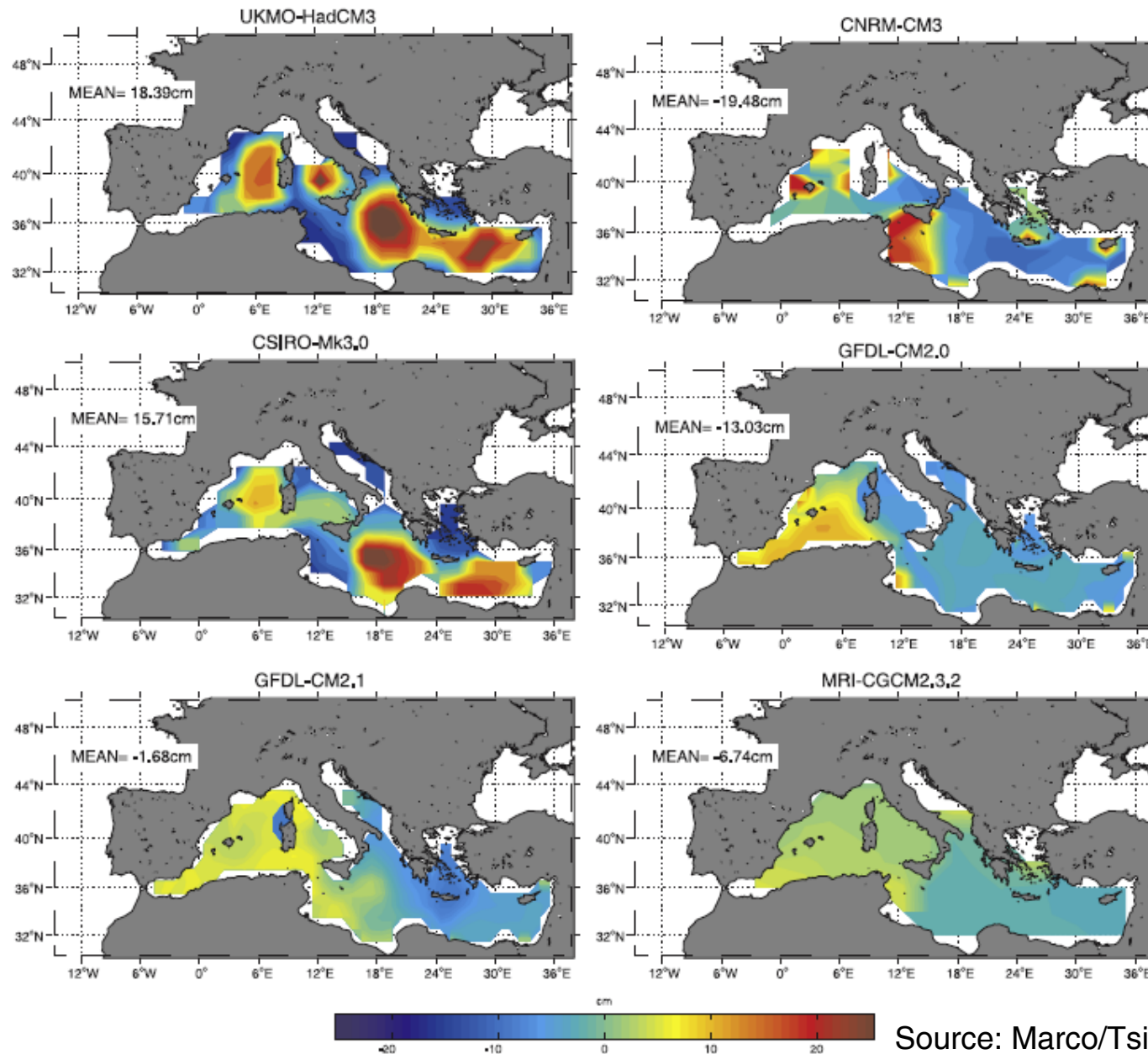
Framework of climate-community interaction



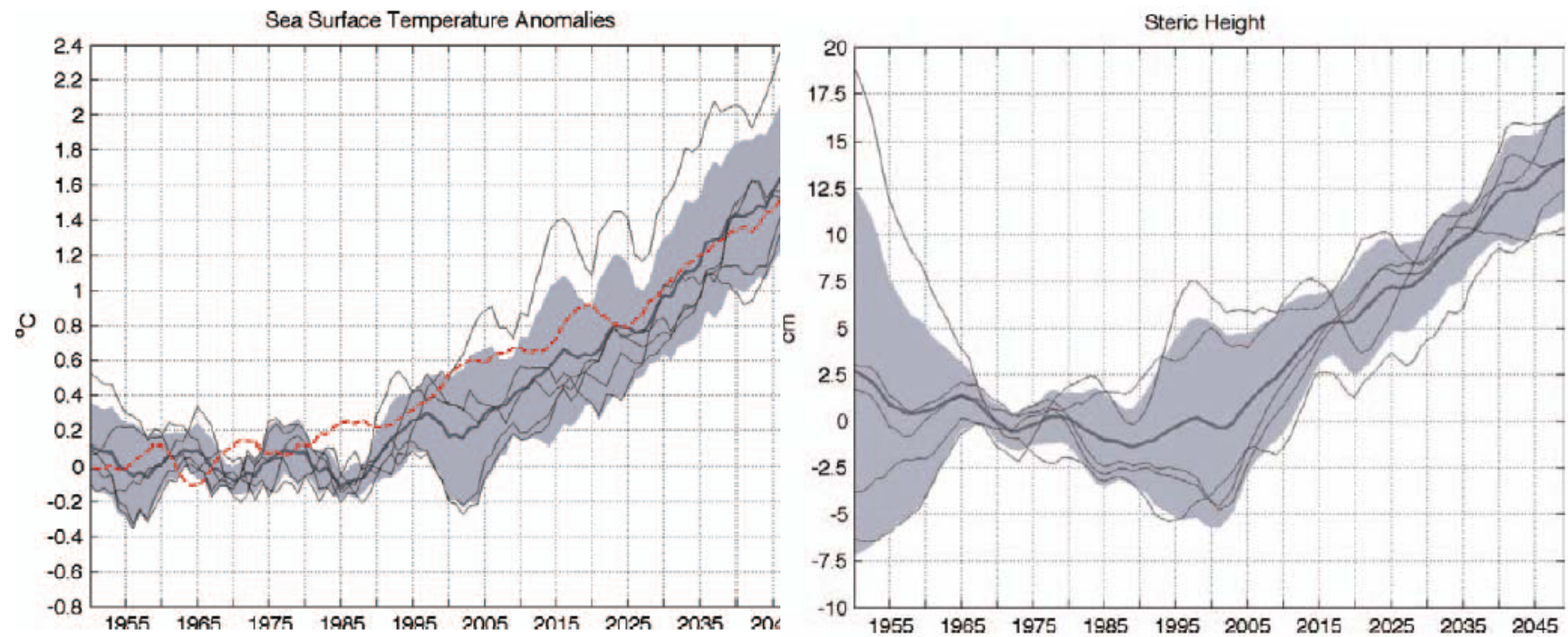
Interaction between communities and regions



Difference of steric sea level averaged over the last and the first decades of the 21st century (SRES A1B)



Results of CIRCE models for the Mediterranean



Source: Gualdi et al. 2013

The coasts of Egypt

- Overall length more than 3500 km
 - Shoreline of Nile delta: 275 km
 - 40% of people of Egypt live along coastlines
 - Coastal areas mainly used for tourism and agriculture
-
- Development of agriculture has caused drying up of wetlands, leading to subsidence
 - Development of coast has removed some natural protection, increasing erosion in some areas



0.5 m sea-level rise

Affected population: 3,800,000
Affected cropland: 1,800 km²



1.0 m sea-level rise

Affected population: 6,100,000
Affected cropland: 4,500 km²



Impacts of sea-level rise on the population and agriculture in the Nile Delta region

- salt water intrusion into aquifers
- losses of arable farm land
- possible relocation of more than 1 million people from Alexandria
- extensive damages to land and infrastructure (e.g. harbors)
- threat to food security of a steadily growing Egyptian population
- conflicts concerning the allocation of water from the Nile

Source: FitzGerald et al. 2008,
based on Simonett & Sestini 2007

Risks to the Egyptian coast with regard to sea level rise

	population	economy	environment	effectiveness of protection
Northwest coast	low risk	moderate risk	low risk	low
Alexandria	moderate risk	high risk	moderate risk	moderate
Nile Delta	moderate risk	high risk	high risk	moderate
North Sinai	low risk	moderate risk	low risk	low

Source: Link/Kominek/Scheffran 2013 (adapted from Frihy and El-Sayed, 2012)

Strategies to deal with sea level changes

- investment of \$ 300 million to install sea walls along most threatened parts of the coast
 - complementing natural protection by artificial structures
 - PROBLEM: intensified erosion adjacent to artificial structures
 - initiative for a National Improvement Plan until 2017 prior to Arab Spring
-
- Successful adaptation to the consequences of sea level rise requires new strategies and increased public awareness and more public participation.



Gender and Environmental Migration (GEM) in the Indus Basin



- To collect data on local perceptions of climate change and variability;
 - To assess the role of migration in and its potential as adaptative strategy to climatic and environmental change;
 - To analyse how vulnerabilities/resilience are shaped by entrenched inequalities shaped by Class/Gender/Caste/Religion ;
- To relate the migration-as-adaptation portfolio to emerging climate change agendas and policies.

Climate Variability & Change AND Water & Land Use

Climate Variability/Change

- Indus Delta is subjected to extreme wave energy
- Tropical Storms erode the coast and breach coastal protection structures
- Sea level rise (few mm/year)

Water/Land Use

- Little or no sediment contribution to Indus delta → subsidence (few mm/year)
- Karachi: coastal sand is mined for construction
- Poor planning of coastal canals lead to erosion

Vulnerability of coastal areas



Mining of beach sand in front of a residential complex at Clifton Beach, Karachi. Inundation of Marine Drive, Clifton Beach occurs regularly during SW monsoon.

Changes in the last decades

Impacts on Coast/Delta

- Delta area reduced from 6000 Km² to 1200 Km² in 40 ys
- Coast is wave-dominated: sand beaches and dunes
- Saline intrusion up to 80 km inland
- Drainage canals for sea water now aggravate

Ecological/Environmental

- Northward shift and loss of biodiversity
- Loss of agricultural land/productivity
- Loss of livelihood sources (fisheries) for coastal settlements
- Hundreds of thousands displaced

→ Field research to explore community perceptions & responses

Impact of sea level rise on small island states

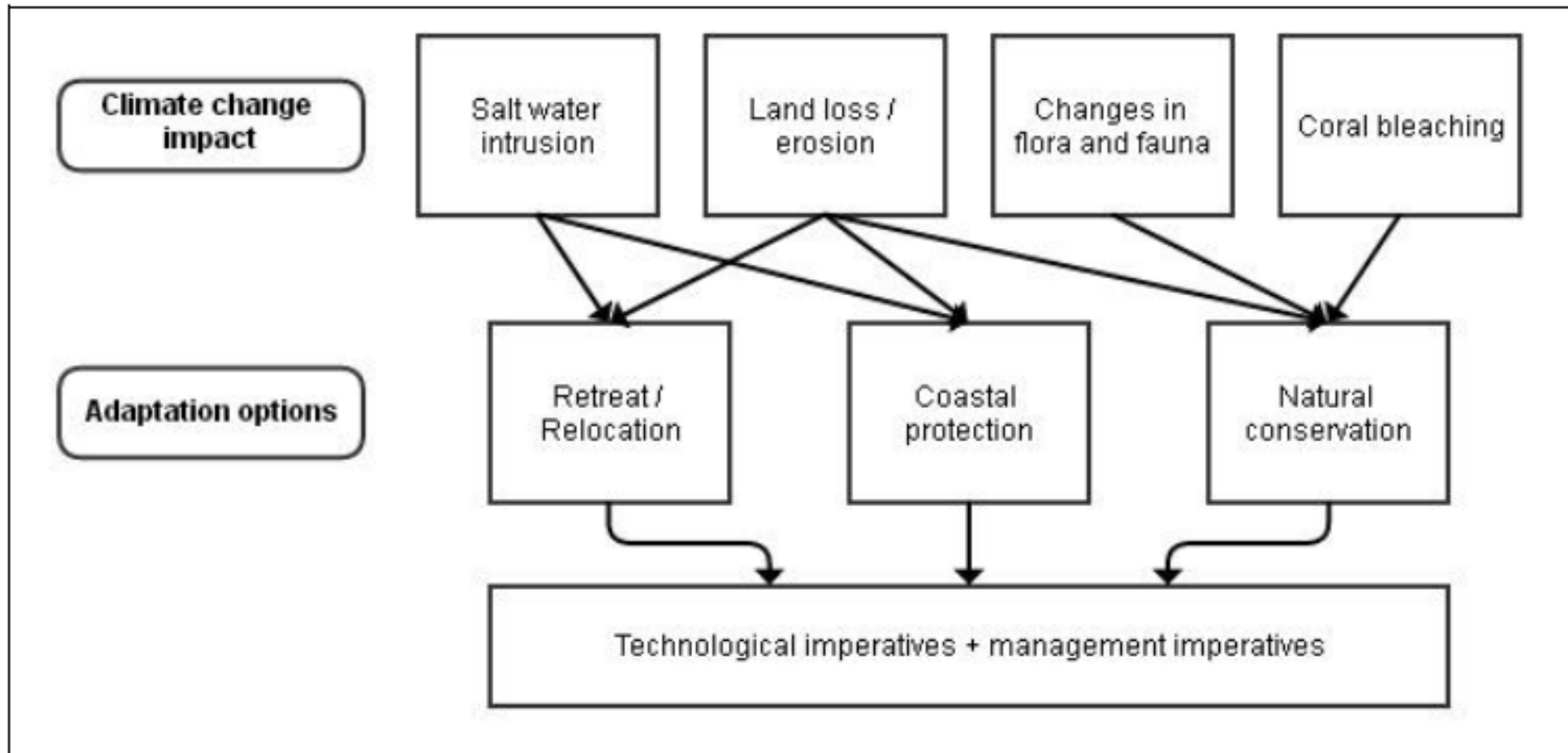
- Small island states particularly vulnerable to sea level rise (IPCC 2007):
 - “Sea-level rise is expected to exacerbate inundation, storm surges, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities. (...)
 - There is strong evidence that under most climate change scenarios, water resources in small islands are likely to be seriously compromised. (...)
 - Climate change is likely to heavily impact coral reefs, fisheries and other marine-based resources. (...)
 - It is very likely that subsistence and commercial agriculture on small islands will be adversely affected by climate change.”

The Maldives: areas affected by sea-level rise



Areas of Maldives capital (Malé) affected by 1m (dark blue) and 2m (light blue) sea level rise (CARE 2009)

Climate change impacts and adaptation option



Source: Petzold/Ratter 2013 (after Nunn 2009)

Summary and conclusions

- Rising sea levels: global indicator of climate change
- Vulnerabilities to changing sea levels: function of exposition, sensitivity and adaptive capacity of communities.
- Consequences and risks for social-ecological systems in coastal communities depend on regionally-specific conditions, socio-economic factors and responses.
- Social resilience to a large degree depends on human perceptions and response patterns to the challenges posed by sea-level rise.
- Integrative framework of climate-society interaction, involving systemic and actor-oriented approaches.