Paper 2: **Climate Change and Capture Fisheries – impacts, adaptation, mitigation, and the way forward**

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Key previous work

- Allison et al 2005 – Review for DFID
- IPCC 2007 – Assessment Report 4
  - WG1 – the science of climate change
  - *WG2 – Impacts, adaptation vulnerability*
    - *Food, fibre and forest products*
    - *Coastal systems and low-lying areas*
- Millennium Ecosystem Assessment 2005
  - Marine and coastal synthesis

‘Impacts, adaptation and mitigation’ of what/who?

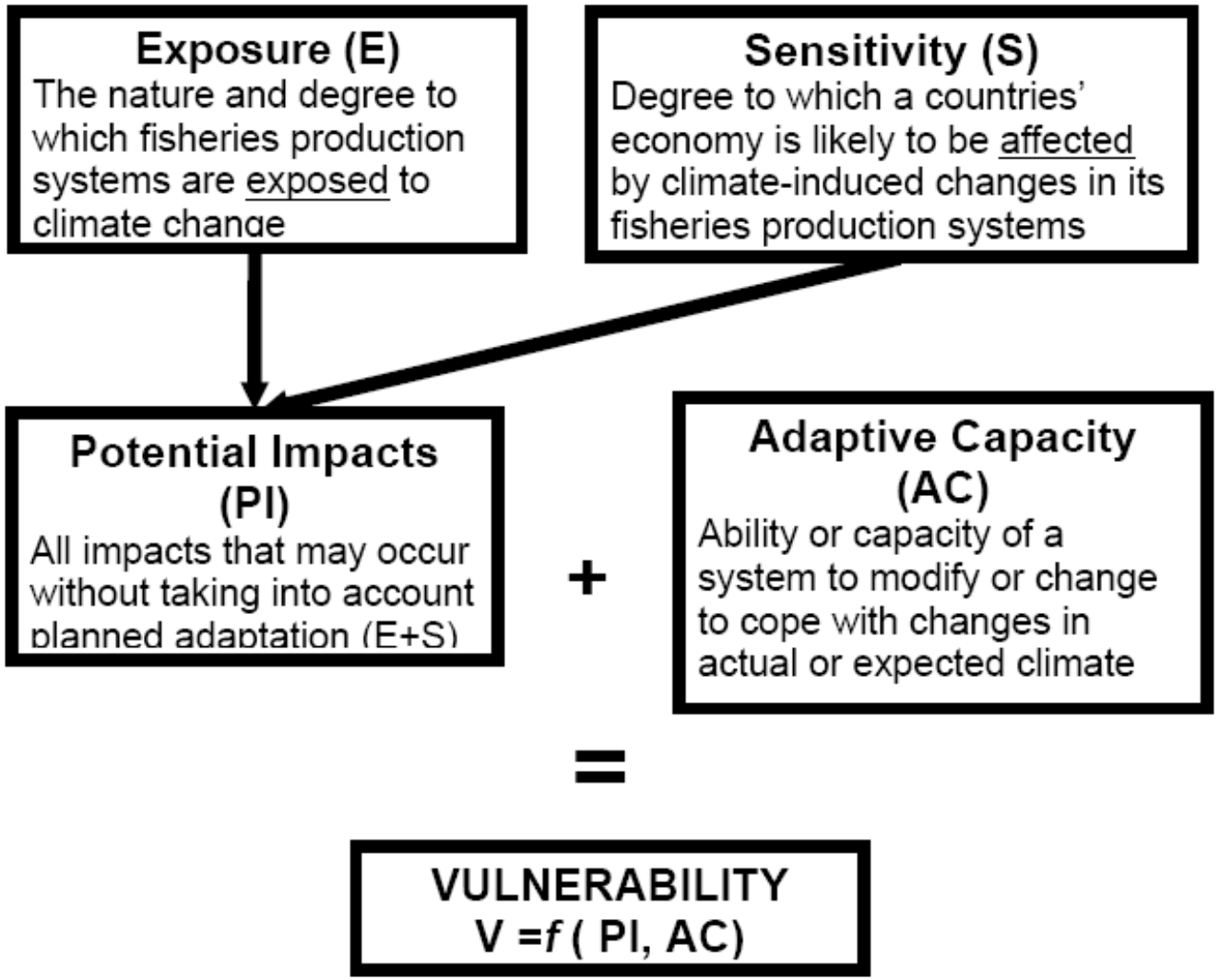
- Fisher folk
- Fishing as a livelihood
- Food security
- Economies
- Sectors
- Marine production systems

Scales of analysis and action

- Regions
- Nations
- Communities
- fishing operations
- Households
- Individuals

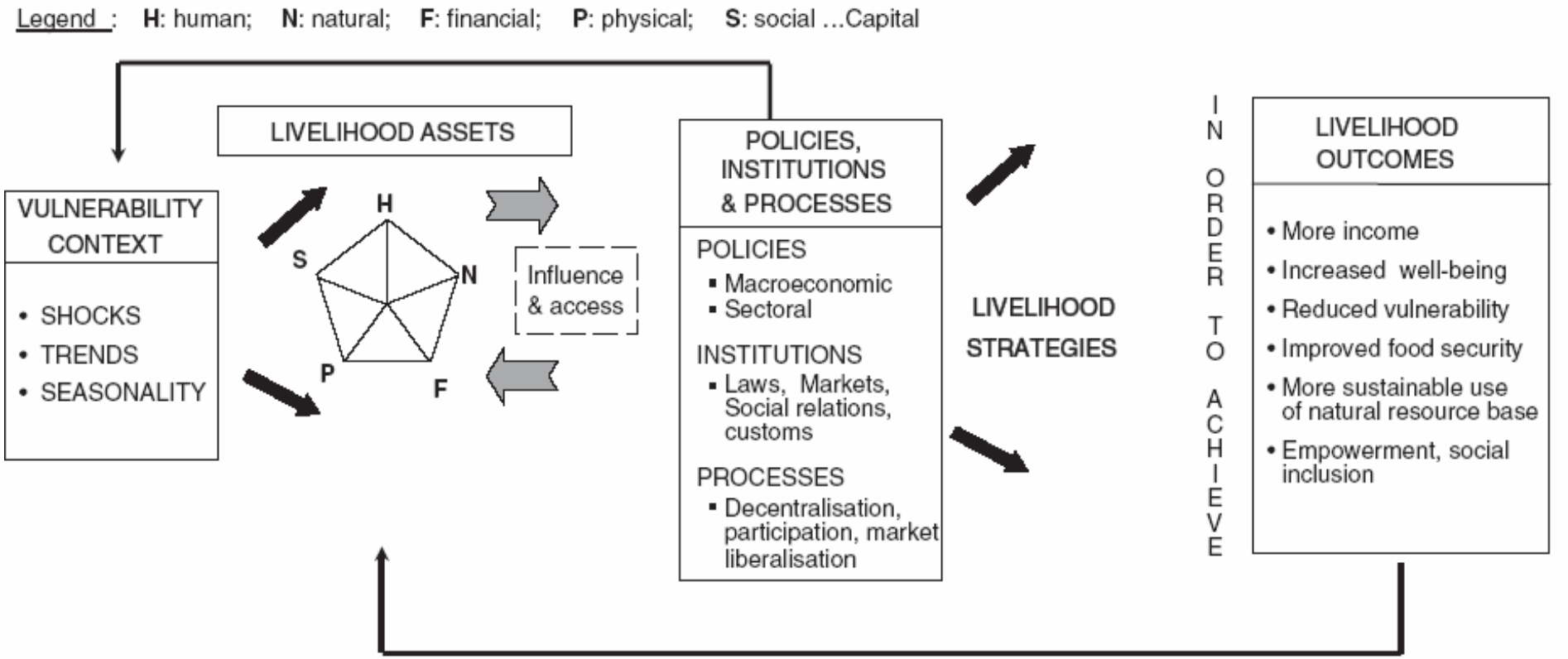
Vulnerability

- "…a function of the character, magnitude, and rate of climatic variation to which a system is exposed, its sensitivity, and its ***adaptive capacity***." (McCarthy et al. 2001:995).
- Much more than exposure to risks.
- highlights factors affecting *adaptive capacity*



(Allison et al. 2005)

Livelihoods



- Result: linkages between sectors in many SSF
- Importance of socioeconomic *context.*

Allison and Horemans 2006

Social-Ecological Resilience (I)

- Multiple linkages and feedbacks between ecosystems & societies
  - *social-ecological systems*
- Complex system behaviours:
  - Threshold behaviour
  - Alternative stable states and phase shifts
  - Self organisation
  - ‘Transformation’ of the system
- Disturbance is normal – equilibrium views are inappropriate
- ‘Expect the unexpected’
- Manage to build ‘resilience’

Social-Ecological Resilience (II)

- “absorb shocks and reorganise … following stresses and disturbance while still delivering benefits for poverty reduction” (Allison et al 2007)
- Not vulnerability, more systems approach
- Adaptive management not command and control
- Social learning, social networks, multiple knowledge sources

CC Mitigation and Fisheries: Contributions and impacts

Capture operations contributions to GHGs

Source	Vessel type	Year	Fuel consumption (million tonnes)	**CO_2 emissions (Tg)**
Eyring (2005) (vessels >100t only)	>100t (23 000 vessels)	2001	23.6[1]	**69[1]**
Tyedmers et al (2005)	All vessels	2001	42	**134**
FAO (2007)	1.3 million decked vessels	2005	14	**43**

- Various fuels used, dependent on sector and vessel type

Fish trade contributions to GHGs

- 53 million tonnes internationally traded in 2004
- ~ ½ million tonne imported by air to US, EU & Asia
  - ~4 Tg CO_2 (3-9% operational emissions)
- Intercontinental Air ~3.5 times more emissions than sea
- Limited figures available on trade routes, means and distances
- Potentially as significant as capture emissions

Mitigation possibilities

- Fuel efficiency
  - Gear type
  - Overcapitalisation
  - Subsidies on fuel
  - Fisheries management – heavily exploited stocks require more fuel
- Transport
  - Trade-off between developing country export benefits and transport emissions

Global mitigation impacts on fisheries

- Profitability of most fishing operations linked to fuel prices
- Controls, carbon-taxes on transportation may impact markets
- Direct impacts of renewable energy projects (offshore wind/wave, hydroelectric energy)
- Geo-engineering projects in oceans (speculative)

Climate change impacts on capture fisheries

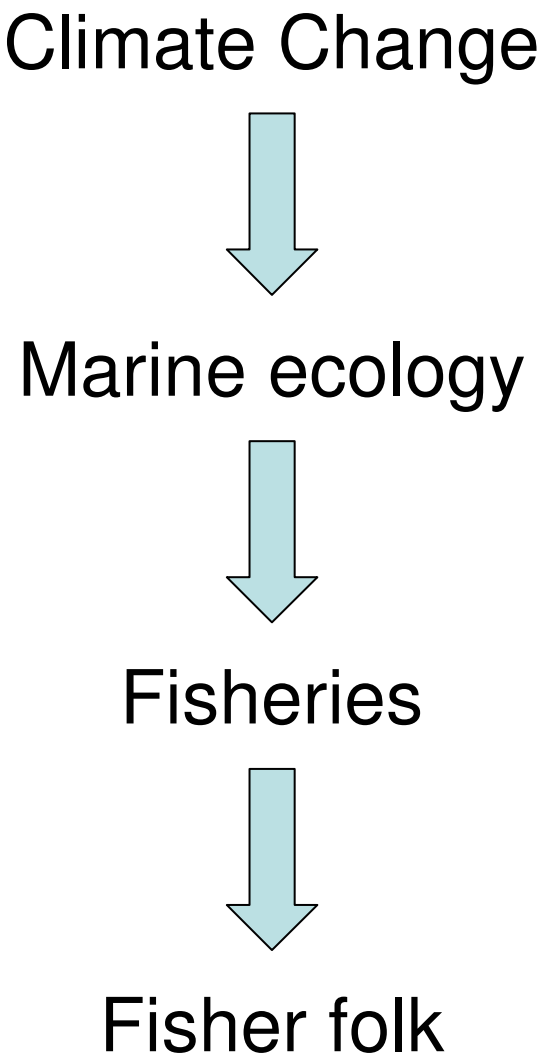
(at the point of impact on fisherfolk and their communities)

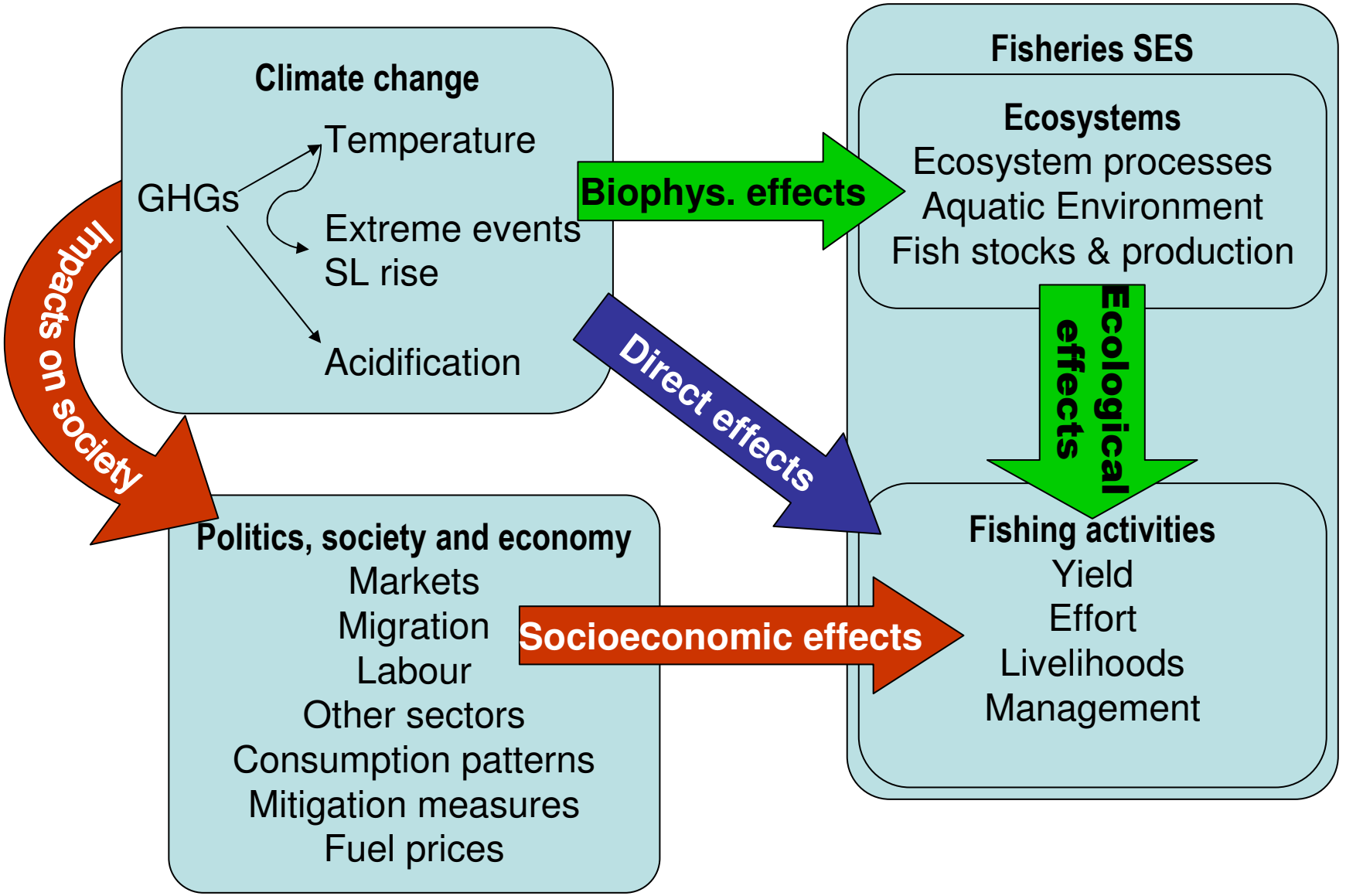
Type of changes	Climatic variable	Impacts	Potential outcomes for fisheries
Physical Environment (Indirect ecological)	Changes in pH through increased CO_2 and acidification	⇒ Effects on calciferous animals e.g. molluscs, crustaceans, corals, echinoderms & some phytoplankton	Potential declines in ***production*** for calciferous marine resources
	Warming upper layers of the ocean	⇒ Warm water species replacing cold water species	Shifts in ***distribution*** of plankton, invertebrates, fishes birds, towards the north or south poles, reduced species diversity in tropical waters
		⇒ Plankton species moving to higher latitudes	
		⇒ Timing of phytoplankton blooms changing ⇒ Changing zooplankton composition	Potential mismatch between prey (plankton) and predator (fish populations) and declines in ***production and biodiversity***
	Sea level rise	⇒ Loss of coastal fish breeding and nursery habitats e.g. mangroves, coral reefs	Reduced ***production*** of coastal and related fisheries
Fish stocks (Indirect ecological)	Higher water temperatures Changes in ocean currents	⇒ Changes in sex ratios ⇒ Altered time of spawning ⇒ Altered time of migrations ⇒ Altered time of peak abundance	Possible impacts on timing and levels of ***productivity*** across marine and fresh-water systems
		⇒ Increased invasive species, diseases and algal blooms	Reduced ***production*** of target species in marine and fresh water systems
		⇒ Changes in fish recruitment success	Abundance of juvenile fish affected and therefore ***production*** in marine and fresh water
Ecosystems (Indirect ecological)	Reduced water flows & increased droughts	⇒ Changes in lake water levels ⇒ Changes in dry water flows in rivers	Reduced lake ***productivity*** Reduced river ***productivity***
	Increased frequency of ENSO events	⇒ Changes in timing and latitude of upwelling	Changes in pelagic fisheries ***distribution***
		⇒ Coral bleaching and die-off	Reduced coral-reef fisheries ***productivity***
Coastal infrastructure and fishing operations (direct)	Sea level rise	⇒ Coastal profile changes, loss of harbours, homes, ⇒ Increased exposure of coastal areas to storm damage	Costs of adaptation make ***fishing less profitable***, risk of storm damage ***increases costs*** of insurance and/or rebuilding, coastal households' ***vulnerability increased***.
	Increased frequency of storms	⇒ More days at sea lost to bad weather, risks of accidents increased	***Increased risks*** of both fishing and coastal fish-farming, making these less viable livelihood options for the poor; ***reduced profitability*** of larger-scale enterprises, insurance premiums rise.
		⇒ Aquaculture installations (coastal ponds, sea cages) more likely to be damaged or destroyed	
Inland fishing operations and livelihoods (indirect socioeconomic)	Changing levels of precipitation	- Where rainfall decreases, reduced opportunities for farming, fishing and aquaculture as part of rural livelihood systems	***Reduced diversity of rural livelihoods***; greater risks in agriculture; greater reliance on non-farm income

- Reduced production
- Increased variability
- Changes in distribution
- Damage to capital assets
- Disruption of operations
- Disruption of trade
- Increase in costs
- Physical threats to communities
- Impacts on other sectors
- Socioeconomic & health impacts on fishing communities
- Resources for management

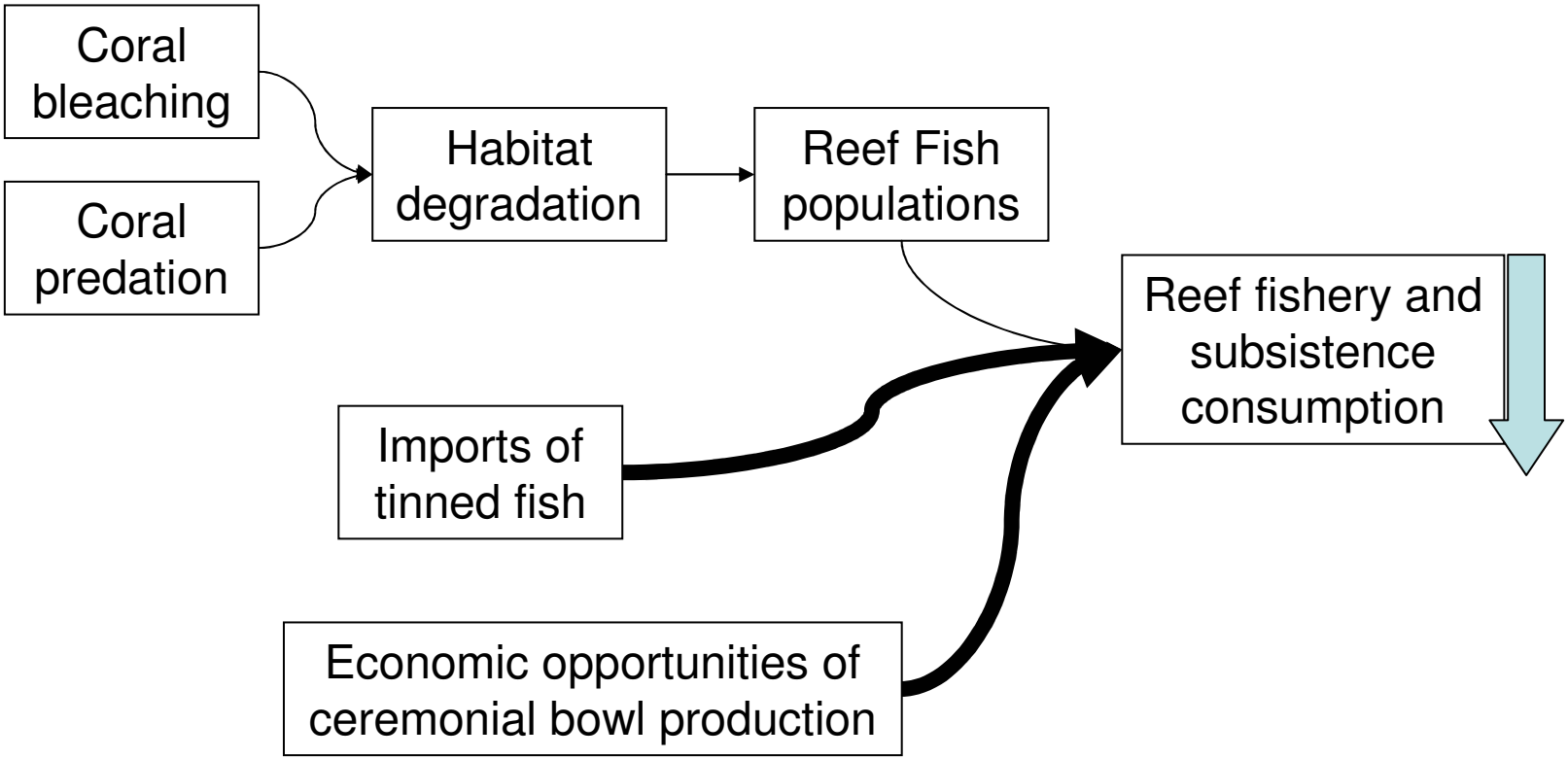
Ecological, direct and indirect socioeconomic effects

- Most research focus is on biophysical and ecological processes
- Is this appropriate from perspective of fisher folk and their communities?
- Climate change will impact many factors in the context of fisheries.




Climate change
Temperature
GHGs
Extreme events
SL rise
Acidification
Impacts on society
Biophys. effects
Direct effects
Fisheries SES
Ecosystems
Ecosystem processes
Aquatic Environment
Fish stocks & production
Ecological effects
Fishing activities
Yield
Effort
Livelihoods
Management
Politics, society and economy
Markets
Migration
Labour
Other sectors
Consumption patterns
Mitigation measures
Fuel prices
Socioeconomic effects

Non-biophysical impacts on Fijian reef fisheries (Turner et al 2007)



Potential positive impacts

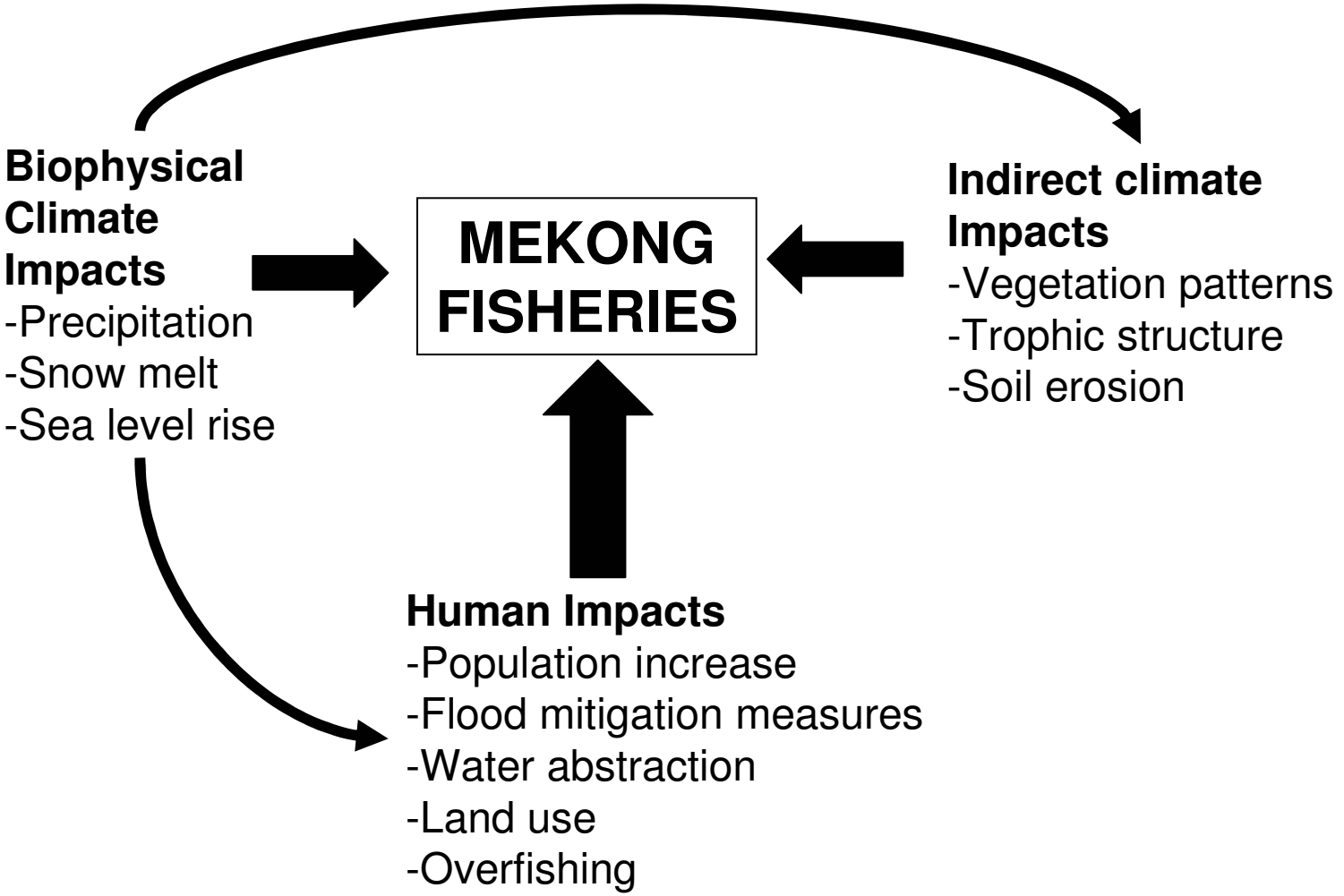
- Scallop fishery in southern Peru
- Increase in production
- Increased fishery, profits, employment, multiplier effect in local economy

- Who can benefit from opportunities of CC
- Poor assumed less adaptive capacity
- Large-scale has more capital invested capital (e.g. Benguela factories)

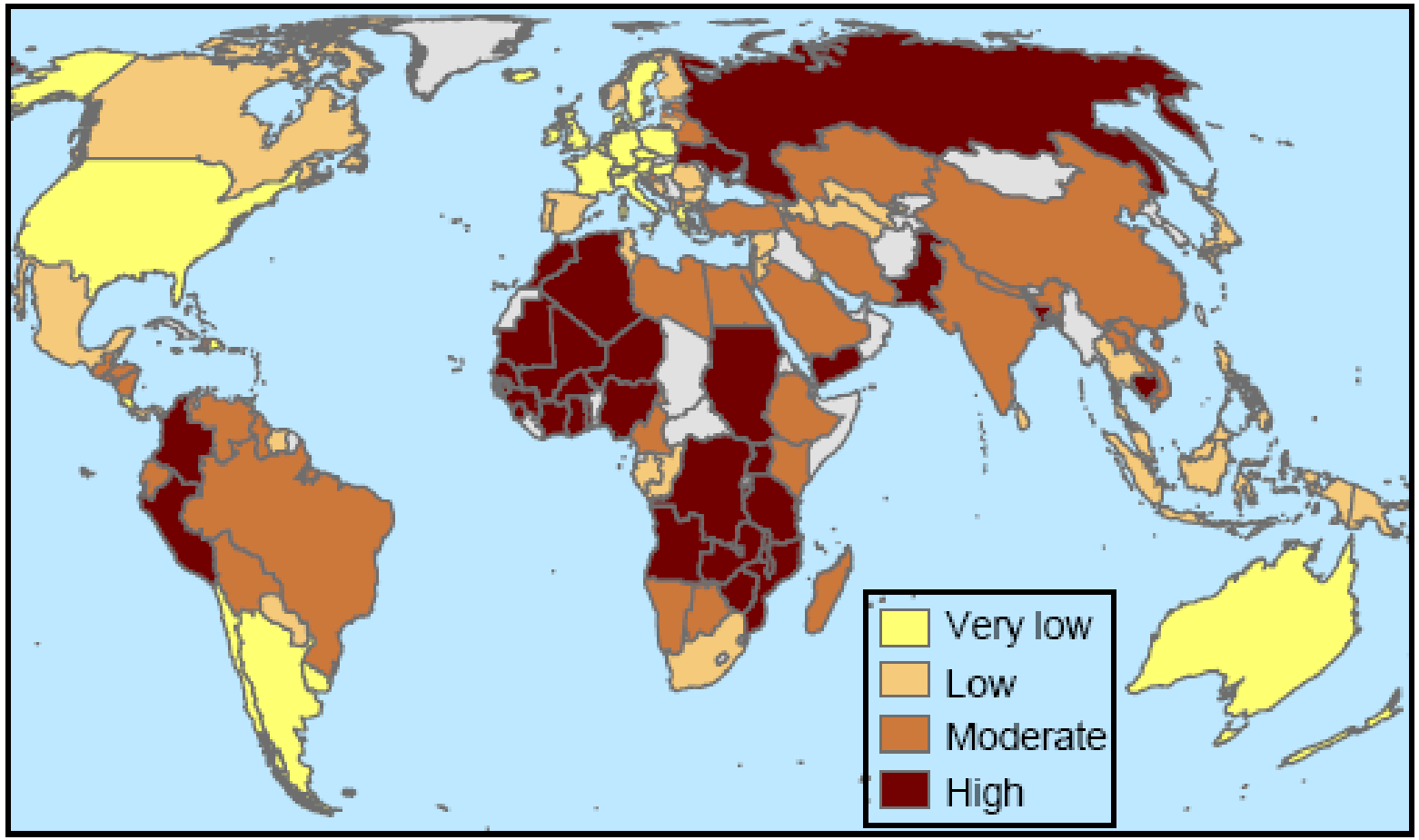
Considerations about impacts

- Impacts relative to trends in population, trade, consumption, development
  - Context of fisheries will evolve due to climate and non-climate factors
- Synergistic and interacting impacts
- Surprises, ‘tipping points’, sudden shifts and misunderstood mechanisms

Synergistic Impacts on the Mekong delta

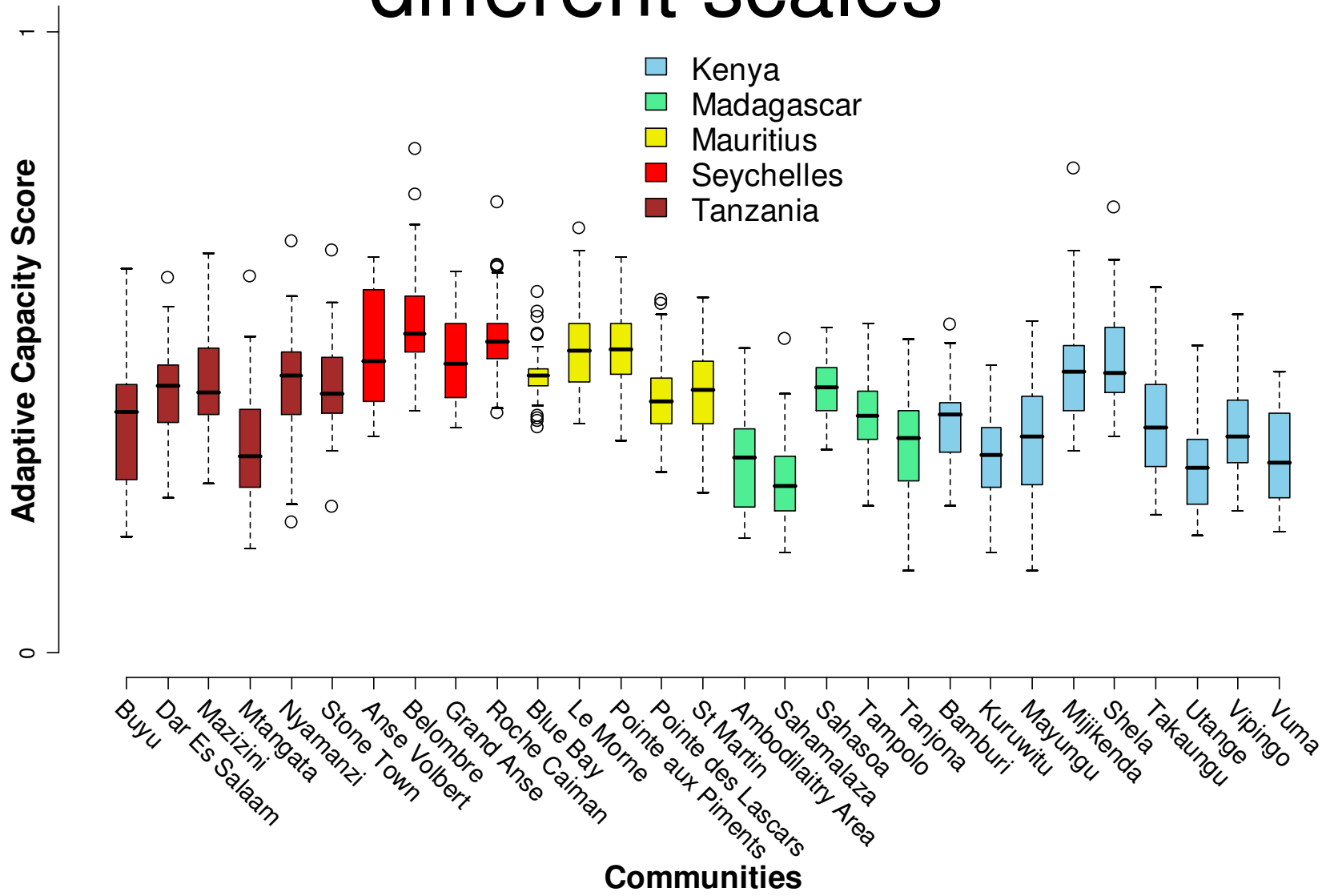


Vulnerability to impacts

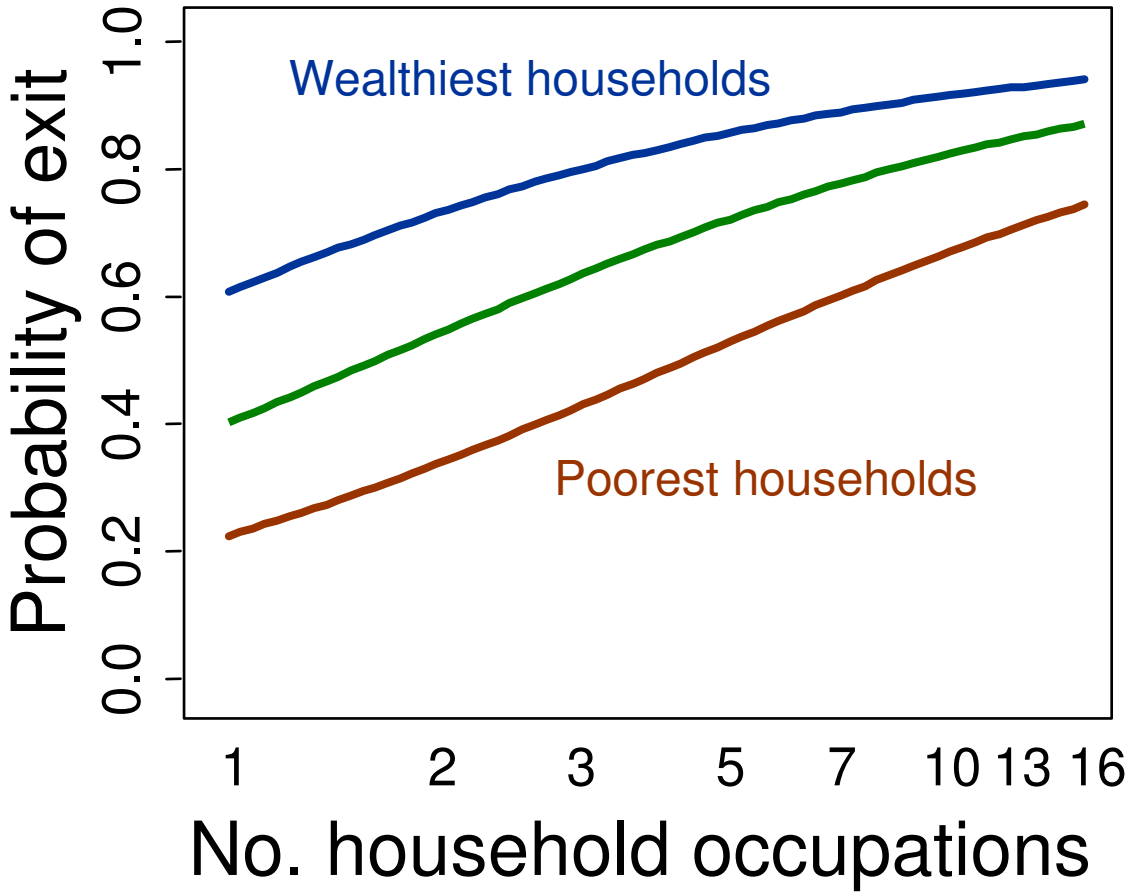


- National economies
- Adaptive capacity is a key determinant of vulnerability

Mapping adaptive capacity at different scales



Readiness to exit a declining Kenyan reef fishery



- Poorest trapped in declining fisheries
- Adaptive capacity varies with:
  - Poverty
  - Gender
  - Ethnicity etc

Cinner, Daw & McClanahan (in prep)

Adaptations

	Anticipatory	**Reactive**
Private	• Private insurance of capital equipment and even of economic returns • Diverse livelihood strategies	• Adjustments in insurance markets • Exiting the fishery for other livelihoods/investments
Public	• Weather and precipitation forecasts • Publicly available research and development	• Insurance underwriting • Assisted migration

See report table 8

Issues and trade-offs with Adaptations

- Adaptations or mal-adaptations
  - Increasing effort to declining yield
  - Tsunami rehabilitation
- Reducing vulnerability may not increase system-wide resilience
  - Insurance schemes
- Inter-sectoral effects
  - Flood mitigation measures impacting floodplain fisheries

Key Messages

1. Most CC/Fisheries literature does not focus on socioeconomic and livelihood impacts
2. Multiple impact pathways: biological, economic, social
   - Interactions
   - Indirect pathways may overwhelm direct ecological pathways
3. Non-climate trends (markets, demographics, exploitation and governance) in the short-term, will have a greater effect on fisheries than climate-change

Key Messages

4. Adaptive capacity is unevenly distributed and poorly researched
5. Investments in improving the adaptive capacity of fisher folk can reduce their vulnerability to generic (and unknown) threats
6. Range of potential adaptations options in fisheries, there may be trade-offs between
   - Efficiency
   - targeting the most vulnerable
   - building resilience of the system.

Proposed Recommendations

1. Research and policy scope should be broadened (beyond direct impacts)
   - How will future impacts look at the context of a warming world?
2. More emphasis on management under uncertainty
   - adaptive approaches
   - adaptive capacity (economic development, diverse livelihoods)
3. Linkages between sectors in research and policy (e.g. Integrated Watershed Management)

Proposed Recommendations

4. Projections should be at a management relevant scale and/or at potential adaptation scales

Key Questions

- Which pathway of impacts are most important?
  - Can we predict this? Should we try?
- What time and spatial scale of research and policy action is appropriate?

Key Questions

- What are implications of uncertainty for policy/action
  - More research to predict?
  - More efforts to increase generic adaptive capacity?
- How new is the climate change challenge?
  - Same old uncertainty
  - Same old aims
    - well managed fisheries are more resilient
    - Poverty alleviation decreases vulnerability
  - Implications for allocation of funds…?
- What else did we forget?!