Building capacity to adapt to climate change in communities engaged in small-scale fishing and aquaculture

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Outline

1. Climate change research: from impacts to responses
2. Key principles: from vulnerability assessments to adaptation actions
3. What is adaptive capacity and how do you measure it?
4. Assessing the outcomes of adaptation actions: from principles to indicators (workshop outcomes)
IPCC 5th Assessment: Sectors of the ‘blue economy’ that are based on living marine resources are all predicted to be negatively impacted under anthropogenic GEC.

Confidence in effects
- Very high
- High to very high
- High
- Medium high
- Medium
- Low

*IPCC confidence levels assigned to impacts on marine industries

- Ocean warming
- Ocean acidification
- Reduce oxygenation
- Increase in extreme weather events
- Ocean & atmosphere circulation changes

- Wild-capture fisheries
- Aquaculture
- Pharmaceuticals, chemicals
- Tourism

Allison & Bassett (2015) Climate change in the oceans: human impacts and responses  *Science*
Engaging citizens in climate action: “Fear won’t do it”

“non-threatening images that relate to every-day emotions and concerns tend to be the most engaging”
Change in production potential of fish (%) by 2055, relative to 2005 values
Cheung et al 2010 *Global Change Biol.*
CC impacts on fisheries and aquaculture

Anthropogenic climate change

Ocean currents
ENSO
Sea level rise
Rainfall
River flows
Lake levels
Thermal structure
Storm Severity
Storm frequency
Acidification

Effects on:

Production
Ecology

Fishing & Aquaculture operations

Communities Livelihoods

Wider society & Economy

Impacts on:

Species composition
Production & yield
Distribution
Diseases
Coral bleaching
Calcification

Safety & efficiency
Infrastructure

Loss/damage to assets
Risk to health & life
Displacement & conflict

Adaptation & mitigation costs
Market impacts
Water allocation

Badjeck, Allison, Halls & Dulvy 2010 Marine Policy
Coral bleaching

Ocean Acidification

Fisheries Shifting North

- Maine
- New Hampshire
- Massachusetts
- Yellowtail flounder
- Rhode Island
- Connecticut
- Red hake
- New York
- New Jersey
- Summer flounder
- Delaware
- Maryland

Average Latitude of Landed Value (°N)

Year

Seawater warming and its implications for fisheries and aquaculture: increased risks from disease?

e.g. PSP agent *Alexandrium catenella* in Puget Sound (Moore et al., 2008)
Key concepts: vulnerability and resilience

“Vulnerability is the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence to capacity to adapt” (Adger, 2006)

"Resilience" as applied to ecosystems, or to integrated systems of people and the natural environment, has three defining characteristics:

• The amount of change the system can undergo and still retain the same controls on function and structure
• The degree to which the system is capable of self-organization
• The ability to build and increase the capacity for learning and adaptation

(Source: www.resalliance.org)
Vulnerability (or resilience) of what (or whom) to what?

- **Vulnerability of places** – low-lying coasts, enclosed seas, deltas, coral reefs, SIDS, LDCs
- **Vulnerability of economic activities** – agriculture, fishing, tourism, transport, habitation etc.
- **Vulnerability of people** – individuals, social groups, households, communities, provinces, nations
- **Vulnerability to particular stressors/hazards**: natural disasters, ENSO events, sea level rise, global environmental change, change in general
How vulnerable are different nations to potential climate change impacts on their fisheries sector? (Allison et al. 2009 Fish & Fisheries)

**EXPOSURE**
Nature and degree to which countries are *exposed* to predicted climate change

**SENSITIVITY**
Degree to which economies & people are likely to be affected by fishery-related changes

**POTENTIAL IMPACTS**
All impacts that may occur without taking into account planned adaptation

**ADAPTIVE CAPACITY**
Abilities and resources to cope with climate-related changes

**VULNERABILITY**

\[ V = E + S + \frac{1}{AC} \]
Where in the world might fisheries be most impacted by climate change, countries most seriously affected by those impacts, and least able to deal with the economic and social consequences?

Vulnerability to the impacts of climate change on the fisheries sector under scenario SRES B2. (Allison et al 2009 Fish and Fisheries)
How vulnerable is Vietnam’s aquaculture sector to climate change?

- Catfish (swai) farming industry vulnerable to freshwater flooding and saline water intrusion from sea level rise

- Shrimp industry resilient to salinity change but vulnerable to stock losses from flooding

Badjeck et al., 2012. WorldFish Center
Climate-related changes in capture fisheries potential affects populations most dependent on fish and most vulnerable to micronutrient deficiencies.

Golden et al., 2016. Fall in fish catch threatens human health Nature 534: 317-320
Vulnerability analysis needs:

Clear aims: vulnerability of who/what to what stressor(s)?
Clear understanding of impact pathways
Clear conceptualization: defined frameworks
Good indicators – theoretical and empirically tested
Strong stakeholder engagement
Appropriate communication and discussion of findings
Clear recommendations for adaptation action
Linking vulnerability analysis to adaptation: the technocratic vision

**Vulnerability analysis**
- Climate exposure model, 2050 & 2100 time steps; IPCC scenarios
- Current values of sensitivity and adaptive capacity

**Targeted adaptation planning**
- National & sub-national plans of adaptation
- Sectoral plans
- Adaptation cost-benefit analysis

**Prioritized adaptation actions**
- Reduce risk exposure
- Reduce sensitivity
- Increase adaptive capacity

*The messy reality:*
Planning cycles use shorter time horizons, action is therefore often deferred.
Society will probably change more than climate by 2050 or 2100.
Adaptation actions respond to perception of thresholds and to multiple stressors, not distant predicted threats.
Adaptation actions are often reactive, autonomous and contingent on political process, not rigorous cost-benefit analysis.
3. What is adaptive capacity and how do you build it?

Whitney et al 2017 Ecol Soc

Fig. 1. Comparison of 11 approaches for assessing adaptive capacity at different spatial scales and with varying attention to social and ecological systems.
Components of adaptive capacity
(Cinner et al, 2018, Nature Climate Change)
What to adapt?

Bio-physical system
- Habitat
- Water quality
- Species

Social and Economic System
- Employment
- Market
- Governance

Scale
- Local
- Regional
- National
- Global

How to adapt?

Drawing on Capital
- Human
- Social
- Natural
- Physical
- Financial

Approaches
- Autonomous
- Planned
- Flexible
- Mandated

Responses
- Social
- Economic
- Technical

Who adapts?

Individuals
- Farmers
- Traders
- Processors
- Retailers
- Consumers

Groups
- Firms
- Communities
- Producer orgs

Government
- Regulatory bodies
- Advisory services

Adaptation Process
(Allison et al., 2011a)
How have fishing communities and economies adapted to variability?

- Mobility and migration (e.g. artisanal fishers in Peru and West Africa)
- Household livelihood diversification; macro-economic diversification
- Acceptance of income & profit variability (multi-year planning); psychological preparedness
- Building substitutable capital assets – human, social, financial

Badjeck et al 2009 Climatic Change; Badjeck et al 2010 Marine Policy
Responding to global climate change impacts in upwelling systems: reducing vulnerability

\[ \text{Exposure} + \text{Sensitivity} = \text{Potential Impacts} \quad (\text{IPCC, 2001; 2007}) \]
\[ \text{Potential Impacts} + \text{Adaptive Capacity} = \text{Vulnerability} \]

<table>
<thead>
<tr>
<th>Reduce exposure to climate hazards</th>
<th>Reduce sensitivity</th>
<th>Increase adaptive capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Vessel tie-up schemes</td>
<td>• Reduce fishing pressure and other stressors on fish populations and ecosystems</td>
<td>• Better weather forecasting</td>
</tr>
<tr>
<td>• Relocation</td>
<td>• Diversify livelihoods and economies</td>
<td>• Improved environmental monitoring and surveillance systems</td>
</tr>
<tr>
<td>• Seasonal weather forecasts</td>
<td>• Diversify diets</td>
<td>• Form associations, networks, societies for risk-sharing</td>
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<tr>
<td>• Early quota-setting</td>
<td></td>
<td>• Index-linked insurance</td>
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Exposure + Sensitivity = Potential Impacts

Potential Impacts + Adaptive Capacity = Vulnerability

(IPCC, 2001; 2007)
Adapting aquaculture systems to change: a farm level view

Reduce exposure to climate hazards
- Support conservation of natural sea defenses
- Raise pond dykes
- Upgrade pumps and sluices
- Relocate

Reduce sensitivity
- Farm more tolerant species
- Reduce dependence on wild-caught seed
- Reduce dependence on fishmeal and fish oil feeds
- Diversify product range
- Diversify livelihoods

Increase adaptive capacity
- Better weather forecasting
- Improved disease surveillance systems
- Form associations, networks, societies
- Insurance
- Savings

Exposure + Sensitivity = Potential Impacts

(IPCC, 2001)

Potential Impacts + Adaptive Capacity = Vulnerability
Measuring adaptive capacity

Indicators and indices are used to measure and monitor change in complex systems

Key principles for indicator choice:

– **Specific**
– **Measurable** (and also *reliable, comparable* and *contextually appropriate*)
– **Achievable** (and also *cost effective*)
– **Relevant**
– **Time-bound** (and also *sensitive*).
A practice-orientated adaptation research agenda...

• What shapes people’s *decisions* to adapt?
• How do you *measure* adaptive capacity?
• How do you *build* adaptive capacity?
• What adaptation actions have already taken place in fisheries and aquaculture systems?
• How does the evolving coastal governance regime enable or constrain adaptation to environmental change?