

The Interaction of Fisheries and Climate Change: Socioeconomic and Management Perspectives

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Abstract

Climate change, operating through related physical changes (e.g. sea level, ocean temperature) has biological implications (e.g. changes in primary productivity) which in turn produce direct impacts on human uses of the ocean (e.g., fishing, tourism, ports) and broader induced impacts on human society (e.g., social, economic, community). In fisheries, the effects of climate change are bound to interact with the effects of fishing, in their cumulative impacts on fish stocks, and on human aspects of the fishery system. It is important to recognize that the overall approach to, and the specific components of, fisheries management will have major effects on this interaction. Accordingly, this paper explores two main considerations. First, socioeconomic and behavioural aspects of fisheries need to be monitored in the face of climate change, as these will likely have strong management and assessment implications. Second, the need to address the combination of climate change and fishing as forcing factors in fisheries reinforces the necessity for adopting a broad-based *precautionary approach* to management decision making, and for re-designing management systems so that their structure and methods are more *robust* and *adaptive*.

Keywords:

Fishery Systems, Robust Fishery Management, Ecosystem Approach
to Fisheries, Climate Change Impacts, Climate Change Adaptation

Introduction

Although with many variations, it is widely understood that climate change, operating through related physical changes (e.g. sea level, ocean temperature), has biological implications (e.g. changes in primary productivity) which in turn produce direct impacts on human uses of the ocean (e.g., fishing, tourism, ports) and broader induced impacts on human society (e.g., social, economic, community) – as indicated in the diagram below.

Given the complex nature of fishery systems (Charles 2001; Garcia and Charles 2007), the effects of climate change are bound to interact in varied ways with the effects of fishing – in their cumulative impacts on fish stocks, and in varied human aspects of the fishery system. The first component of this paper focuses on such interactions involving (a) socioeconomic and behavioural aspects of fisheries, which need to be monitored in the face of climate change, and (b) four key concepts providing a framework for addressing socioeconomic realities. The second component concerns the various management and assessment implications that arise in relation to the combination of climate change and fishing as forcing factors in fisheries. These considerations reinforce the necessity of adopting a broad-based *precautionary approach* to management decision making, and for re-designing fishery management systems so that their structure and methods are more *robust* and *adaptive*.

Climate Change

- ▶ Related Physical Changes (e.g. Sea Level, Ocean Temperature)
- ▶ Biological Implications (e.g. Changes in Fish Distribution)
- ▶ Direct Impacts on Human Uses (e.g., Fishing, Tourism)
- ▶ Induced Impacts on Human Society (e.g., Social, Economic, Community)

Socioeconomic Perspectives

In considering the links of fishing and climate change, there are many socioeconomic avenues through which we can envision such interactions arising. For example, these considerations could include:

- Economic structure and adaptability
- Benefits, costs and net benefits
- Distributional impacts by sector and by location
- Impacts on markets
- Social and cultural factors in fisheries and fishing communities
- Aspects of local ecological knowledge and fisher knowledge

Furthermore, we can expect that such interactions can be assessed by, and will vary according to, (a) spatial scale (local to international), and (b) time scale (short-term to long-term).

In the emerging literature on assessing the interactions of fisheries and fishing communities with climate change, and the related themes of fishery governance and sustainability, certain concepts have been identified as of particular importance. Here we note four of these: resilience, vulnerability, impacts and adaptation.

1. **Resilience** is the ability to persist, absorbing shocks and perturbations without collapsing, self-destructing or otherwise entering an intrinsically undesirable state. In a fishery context, a resilient fishery can be considered as comprised of a resilient ecosystem; a resilient management institution; a set of resilient fishing communities, and a resilient socioeconomic structure. Focusing on social and economic dimensions, IPCC (2001) notes:

“Socioeconomic resilience is the capability of a society to prevent or cope with the impacts of climate change and sea-level rise, including technical, institutional, economic, and cultural ability. Enhancing this resilience is equivalent to reducing the risk of the impacts on society.”

2. **Vulnerability** has been defined as “the degree to which a system is susceptible to climate change, and is unable to cope with the negative effects ...” (IPCC, 2007). More precisely, Allison et al. (2009, p. 175) suggest that:

“Vulnerability to climate change depends upon three key elements: exposure (E) to physical effects of climate change, the degree of intrinsic sensitivity of the natural resource system or dependence of the national economy upon social and economic returns from that sector (S), and the extent to which adaptive capacity (AC) enables these potential impacts to be offset.”

Thus vulnerability relates to both ecosystem and natural resource aspects (such as the nature and sensitivity of the ecosystem) and to human aspects. With respect to the latter, there are major data limitations at all scales relating vulnerability, and certainly in terms of interactions between fishing and climate change. Such limitations range from a lack of knowledge of adaptive capacity in particular fishing communities, through to a shortage of information about social and economic factors at national and international scales.

3. **Impacts** represent one of three main ingredients that predominate in discussions of climate change, the others being mitigation (reduction of climate change drivers) and adaptation (discussed below). This paper will not deal with mitigation, but rather will focus on impacts of change, and adaptation to the change. Considering impacts, it has been noted that:

“Climate change may impact fisheries in at least two different ways: by altering the

availability of fish to fishermen (direct impact) and by changing the price of fish products and fisheries inputs (indirect impact)." (Allison et al, 2005)

Given these multiple effects, it is not surprising that there are differential impacts across fisheries and fishing communities:

"Some fisheries and aquacultural enterprises and communities would benefit from the results of climate change and others would suffer losses, with economic and population dislocations probably inevitable in many parts of the world" (Kennedy, 1990).

Particularly at risk are immobile fishing communities and non-mobile fishing fleets that are dependent on local resources and that could lose out as fish stocks redistribute spatially (as well as communities become submerged underwater).

4. Adaptation is the fourth key concept relating to socioeconomic linkages that will be outlined here. As Daw et al. (2009, p. 125) note :

"Adaptation is an active set of strategies and actions taken by people in reaction to, or in anticipation of, change in order to enhance or maintain their well-being."

While a variety of technological adaptations can be envisioned (e.g., building sea walls), Daw et al. (2009, p. 127) emphasize that "A technical approach to adaptation can underestimate the importance of institutions (especially informal) to facilitate or limit adaptation." Indeed, a major focus in understanding and encouraging adaptation to climate change involves the idea of 'adaptive capacity':

"...the capacity to modify exposure to risks associated with climate change, absorb and recover from losses stemming from climate impacts, and exploit new opportunities that arise in the process of adaptation." (Allison et al., 2005)

"Planning effective adaptation to climate change and its associated risks requires robust and transferable methods of identifying who and what is vulnerable and the capacity of systems and social groups to cope with both climate variability and climate change." (Allison et al, 2005, p. 19)

The **fishing community** is a fifth theme in approaching the linkage of fishing and climate change, one of special relevance to small-boat coastal fisheries. In much of the world, the role of fish as local food is paramount, and as Daw et al. (2009) note:

"Food security in fishing communities will be affected by climate change through multiple channels, including movement of people to coasts, impacts on coastal infrastructure and living space, and ... pathways of fisheries productivity and availability."

More generally, how will a specific coastal community and its fishing population be

affected by climate change? What adaptations are needed by community-based fisheries (www.coastalcura.ca), which may need to change species mix, diversify markets and diversify the overall economy, given their relative immobility? Down-scaling of global climate models may provide a vehicle to address these ‘local’ matters, albeit with very high uncertainty.

Fisheries Management Perspectives

A wide variety of coastal communities, nations, international bodies, nongovernmental organizations and many others have been wrestling with the challenges of fisheries management for well over a hundred years, and in many cases, for multiple centuries. The emerging concerns due to climate change exacerbate the challenges, and indeed create some new problems, such as those revolving around long-term distributional shifts in fish stocks, and an increasing frequency of extreme weather events affecting coastal areas. In some senses, however, it may well be that the key developments that are needed to move forward in fishery management – see, e.g., Charles (2001) and De Young et al. (2008) – remain valid in the presence of climate change, and are indeed made more urgent. In other words, climate change reinforces the need for fishery policy change.

For example, the three attributes of flexibility, adaptability and robust management, which relate closely to the precautionary approach, are already cornerstones of an emerging consensus for change in fishery governance (Charles 2001, 2005). Folke and Berkes (1995) urge moves “to make institutional arrangements more diverse... and to make management systems more flexible, accommodating of environmental perturbations.” Similarly, adoption of robust management measures – defined as those that are more likely to produce reasonable success in meeting societal objectives, even given incorrect understanding of the fishery and imperfect capability to control fishing activity – help to avoid the “Illusion of Certainty” and the “Fallacy of Controllability” (Charles 1998, 2001, 2005).

The desirability of such moves is reinforced within a world of climate change:

“Changes in species distribution and increased climate variability mean flexible policies are needed to allow the commercial fishing industry to adapt to climate change.” (Hobday et al, 2008, p. 46)

“...the key issues are to tailor the expected future capacity of the fishing industry to expected future fish production and to encourage the development of vessel designs that allow switching among fisheries for different species.” (Jennings and Brander, 2009, p. 8)

Some avenues to robust management include use of mutually-reinforcing management portfolios, a focus on self-regulatory institutions, institutionalizing adaptive learning, and applying the subsidiarity principle in management (Charles 2001, 2005).

Another key element of modern fishery governance is that of use rights (access rights)

and management rights (Charles 2002). Individual fishers, companies and communities often have access to fisheries on a spatial basis, i.e. with rights to fish in a certain area. Particularly for small-boat coastal fisheries, these access rights need to be more flexibly designed in a world of climate change. Hobday et al. (2008, p. 39) note that “As species distributions change, fishers' access to stocks in one region may diminish, while fishers in the new region may not have access rights.” Accordingly, to avoid lost livelihoods in place-based fishing communities, it is important to have access to whatever fish happen to be in the local fishing grounds, not to rigidly-set species-defined limits.

Conclusion

Researchers worldwide are increasingly focused on the implications of climate change, for specific ecosystems, particular regions, particular industries, certain societal groups, and so on. In this brief paper, the emphasis has been on the links of climate change and fishing, from socioeconomic and management perspectives. This has led fundamentally to a realization that many of the socioeconomic concerns in fisheries, as well as many of the management and governance thrusts in the sector, remain valid in a world of climate change – and indeed the importance of these is reinforced by the existence of another driving force in the fishery system.

However, it must be noted that climate change increases the uncertainties and the risks faced by fishers, fishing communities and fishery managers. Thus the urgency needed in dealing with underlying issues is also increased considerably.

References

- Allison, E.H., Perry, A.L., Badjeck, M-C., Adger, W.N., Andrew, N.L., Brown, K., Conway, D., Halls, A., Pilling, G.M., Reynolds J.D. and Dulvy, N.K. (2009) Vulnerability of national economies to potential impacts of climate change on fisheries. *Fish and Fisheries* 10:173-196.
- Allison, E.H., Adger, W.N. and Badjeck, M.-C. (2005) *Effects of Climate Change on the Sustainability of Capture and Enhancement Fisheries Important to the Poor: Analysis of the Vulnerability and Adaptability of Fisherfolk Living in Poverty*. Fisheries Management Science Programme, DFID, UK. R4778J, <http://www.fmsp.org.uk>, 174pp.
- Charles, A. (1998) Living with uncertainty in fisheries: Analytical methods, management priorities and the Canadian groundfishery experience. *Fisheries Research* 37:37-50.
- Charles, A. (2001) *Sustainable Fishery Systems*. Blackwell Science, Oxford UK, 384p.
- Charles, A. (2002) Use rights and responsible fisheries: Limiting access and harvesting through rights-based management. In: (Cochrane, K., ed.) *A Fishery Manager's Guidebook. Management Measures and their Application*. FAO Fisheries Technical Paper, No. 424, Food and Agriculture Organization of the U.N., Rome, 231p.

Charles, A. (2005) Toward sustainable and resilient fisheries: A fishery-system approach to overcoming the factors of unsustainability. In (J. Swan and D. Greboval, eds.) *Overcoming Factors of Unsustainability and Overexploitation in Fisheries: Selected Papers on Issues and Approaches. International Workshop on the Implementation of the International Fisheries Instruments and Factors of Unsustainability and Overexploitation in Fisheries. Siem Reap, Cambodia, 13-16 September 2004.* FAO Fisheries Report. No.782. Food and Agriculture Organization of the United Nations, Rome Italy (2005).

Daw, T., Adger, W.N., Brown, K., and Badjeck, M.-C. (2009). Climate change and capture fisheries. In: (Cochrane, K., De Young, C., Soto, D., eds.) *Climate change implications for fisheries and aquaculture: Overview of current scientific knowledge.* FAO Fisheries Technical Paper, 530. FAO, Rome. 216pp.

De Young, C., Charles, A., and Hjort, A. (2008) *Human Dimensions of the Ecosystem Approach to Fisheries: An Overview of Context, Concepts, Tools and Methods.* Fisheries Technical Paper 489. FAO, Rome Italy. 152p.

Folke, C., and Berkes, F. (1995) Mechanisms that link property rights to ecological systems. In (S. Hanna & M. Munasinghe, eds.) *Property Rights and the Environment: Social and Ecological Issues.* Beijer International Institute of Ecological Economics and the World Bank. Washington, U.S.A.

Garcia, S.M., and Charles, A. (2007) Fishery systems and linkages: from clockwork to soft watches. *ICES Journal of Marine Science* 64:580-587.

Hobday, A.J., Poloczanska, E.S. and Matear, R.J. (eds) (2008) *Implications of Climate Change for Australian Fisheries and Aquaculture: a Preliminary Assessment.* Report to the Department of Climate Change, Canberra, Australia. August 2008. URL: <http://www.climatechange.gov.au/impacts/publications/pubs/fisheries.pdf>

IPCC (2001) *Climate Change 2001: Impacts, Adaptation & Vulnerability, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change,* Cambridge Univ. Press, Cambridge, U.K.

IPCC (2007) Summary for policymakers. In: (M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. v. d. Linden and Hanson, C.E, eds.) *Climate change 2007: impacts, adaptation and vulnerability.* Contribution of working group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge Univ. Press, Cambridge, UK.

Jennings, S., and Brander, K. (2009) Predicting the effects of climate variation and change on marine communities and the consequences for fisheries. *Journal of Marine Systems,* In Press.

Kennedy, V.S. (1990) Anticipated effects of climate change on estuarine and coastal fisheries. *Fisheries,* 15:16-24.