The Challenges of Climate Change for Aquaculture

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The world's dependence on the capture fisheries and aquaculture sector is threatened not only by inadequate management of these aquatic resources but also on factors external to the sector such as climatic change. Fishers and fishfarmers in coastal and inland areas are particularly vulnerable to the direct and indirect impacts of climate change.

FAO, recognizing the importance of addressing food security and poverty reduction issues in the face of climate change and energy security, hosted a High-Level Conference on World Food Security: the Challenges of Climate Change and Bioenergy, in Rome, from 3 to 5 June 2008[1]. In preparation for this conference, the Fisheries and Aquaculture Department organized an Expert Workshop on "Climate Change Implications for Fisheries and Aquaculture", 7-9 April 2008 (FAO, 2008), in order to provide the conference with a coherent and high quality understanding of climate change issues related specifically to fisheries and aquaculture. This workshop also served as a response to a request by the FAO Committee on Fisheries (27th Session). It identified and reviewed key issues of climate change in relation to fisheries and aquaculture and suggested policy options and activities to minimize its negative impacts, improve mitigation and prevention and build adaptive capacity in aquatic resource-dependent communities.

How are aquatic ecosystems supporting aquaculture affected by climate change?

Climate change is felt through the modifications it brings to ecosystems and their productivity, and is characterized by its unpredictability and the large uncertainty that has to be factored in all models and the reaction of ecosystems to such changes. Such modifications include the following:

- Climate change is modifying the geographical distribution of areas offering optimal biophysical conditions for marine and freshwater farmed species. Increased risks of species invasions and spreading of diseases provide additional concerns. This is particularly relevant for the transboundary movement of live organisms used in aquaculture.

- In a warmer world, ecosystem productivity is likely to be reduced in most tropical and subtropical oceans, seas and large lakes, and increased in higher latitudes. Increased temperatures will affect physiological processes of aquatic plants and animals resulting in both positive and negative effects on aquaculture production systems.

- Differential warming between land and oceans and between polar and tropical regions will affect the intensity, frequency and seasonality of climate patterns (e.g. El Niño) and extreme events (e.g. floods, droughts, storms) affecting the stability of marine and freshwater resources adapted to or affected by these. This has unpredictable consequences for aquatic production.

- Sea level rise, glacier melting, ocean acidification and changes in precipitation, groundwater and river flows will significantly affect coral reefs, wetlands, rivers, lakes and estuaries, requiring adapting measures to exploit opportunities and minimize impacts on fisheries and aquaculture systems.

In addition to the environmental changes brought about by climate change, the livelihoods of those depending on aquatic ecosystems for aquaculture activities will be indirectly affected by climate-related events. These include:

- Changes in habitats and physical/chemical conditions will require changes in farming practices and aquaculture operations, including selecting or adapting species and strains adapted to new growing conditions, with implications on the training and educational support needed.

- Extreme events will also impact on infrastructure, ranging from

farm sites to post-harvest facilities and transport routes. They will also affect safety in coastal zones and, at sea, with communities living in low-lying areas at particular risk.

- Global water stress and competition for water resources will affect aquaculture operations and are likely to increase conflicts among water-dependent activities.

- Reduced livelihood options inside the fishery sector will force occupational changes and may increase social pressures. However, the lack of options for diversification outside fisheries or aquaculture could negatively affect households' overall livelihood outcomes.

- Consequently, gender tensions may be heightened in the face of competition for access to resources and occupational change in markets, distribution and processing, where women currently play a significant role.

Will aquaculture be hit harder by climate change? If so, where?

Since the largest proportion of world aquaculture production is concentrated in tropical and sub-tropical climatic regions, and geographically in the Asian region, impacts from climate change are likely to have greater consequences there, with direct impacts on global food fish supply. However, it is predicted that global warming and the consequent increase in water temperature could impact significantly and negatively on aquaculture in temperate climatic zones, because such increases could exceed the optimal temperature range of cultured organisms, as opposed to potential positive impacts through enhanced growth and production in tropical and sub-tropical zones. Other impacts associated with higher temperatures such as eutrophication in inland waters may be increasingly experienced along with possible outbreaks of virulent pathogens that had remained dormant under colder temperatures. Such changes will affect more aquaculture in temperate zones.

One of the most important, but indirect, impacts of climate change on aquaculture is likely to be brought about from limitations on fish meal and fish oil availability for feeds through a reduction in raw material supplies. These limitations will be mainly felt by aquaculture in temperate regions, where the mainstay of finfish aquaculture is based on carnivorous species. Increased variability in fish meal and fish oil availability resulting from El Niño and other climate-related events will not only affect aquaculture but all forms of animal farming, albeit to varying degrees.

What can be done to increase the resilience and adaptability of the aquaculture sector?

Adaptation strategies for the aquaculture sector have to be context- and location-specific and need to consider both short-term (e.g. increased frequency of severe events) and long-term impacts (e.g. increasing water temperature). Adaptation must operate at community, national and regional levels and will require, and benefit from, stronger capacity building.

1. Implementation of an ecosystem approach to aquaculture

Options to increase resilience and adaptability through improved aquaculture management include the adoption as standard practice of adaptive and precautionary management. Through the holistic approach to aquaculture development it provides, the ecosystem approach to aquaculture (EAA)[2] offers a unique opportunity to increase the resilience and sustainability of aquatic resources ecosystems (including fisheries), aquaculture production systems,

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Top: Salmon cages after an unusual storm
Bottom: Destroyed coastal village in the aftermath of Cyclone Nargis, Myanmar

and aquatic resource-dependent communities in the face of climate change.

2. Research and adoption of integrated and non-fed/less-fed aquaculture systems

Adaptations include changing to less carnivorous species, genetic improvements, feed source diversification, better feed formulation, quality control and management. The farming of extractive species – using nutrients and carbon directly from the environment such as bivalves and macro-algae – may deserve further attention for its positive impacts on the ecosystem and potential food security benefits. Integrating aquaculture with other practices, including agro-aquaculture, multitrophic aquaculture and culture-based fisheries, also offers the possibility of recycling nutrients and using energy and water much more efficiently. Short-cycle aquaculture may also be valuable, using new species or strains and new technologies or management practices to fit into seasonal opportunities. Aquaculture also could be a useful adaptation option for other sectors, such as coastal agriculture under salinization threats, and could also have a role in biofuel production, through use of algal biomass or dis-

Excessive rain can cause land slides affecting coastal farms

cards and by-products of fish processing. For feed-based aquaculture, reducing dependence of capture fisheries on fish meal and oil through alternative feeding materials and formulation strategies will be particularly important in maintaining and expanding output while containing costs and energy inputs. In addition, research into genetic improvements will be required to improve resilience to climate change (e.g. genetic improvement for more efficient feeding and diet specificity, and for increasing species resistance to higher temperatures, lower oxygen and pathogens).

3. Development and implementation of policies and strategies to enhance the resilience and adaptability of aquaculture-based livelihoods to climate change

National climate change adaptation and food security policies and programmes need to fully integrate aquaculture and the livelihoods of those it supports. If non-existent, such policies should be drafted and enacted immediately to ensure that potential climate change impacts are integrated into broader national development planning. Strategies promoting diversification options for households outside the sector, along with access to aquaculture crop insurance against potentially reduced or more variable yields should be emphasized. In addition, in the face of more frequent and severe weather events, strategies for reducing vulnerabilities of aquaculture-reliant communities could include investment and capacity building on improved forecasting, implementation of early warning systems and safer infrastructure building. More generally, adaptation strategies should promote disaster risk management, including disaster preparedness, and integrated coastal area management. Adaptations by other sectors will have impacts on inland fisheries and aquaculture (e.g. irrigation infrastructure, dams, fertilizer runoff), and will require careful consideration of trade-offs and interactions between food production systems.

Climate change will impact aquaculture and the livelihoods it supports, but will also create opportunities for new development. Whilst increasing preparedness to the consequences of extreme weather events and adaptation in communities most at risk are prerequisites for improved resilience to climate change, future challenges lie in identifying where aquaculture has a particular role to play. In this context, the flexibility and variety of fish production systems, if supported by necessary research, integrated development approaches, capacity building and diversification policies, will be a major asset in taking advantage of the 'niches' created by climate change and in maintaining overall fish production outputs.

More information, including the technical report of the Expert Workshop, is available at:
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[1] http://www.fao.org/foodclimate/expert/em7/outputs-em80/en/

[2]The Ecosystem Approach to Aquaculture (EAA) is a strategic approach to development and management of the sector aiming to integrate aquaculture within the wider ecosystem such that it promotes sustainability of interlinked social-ecological systems (FAO, 2007; Soto *et al*., 2008).

FAO. 2007. Sustainable growth and expansion of aquaculture: an ecosystem approach, pp. 76-84. State of the World Fisheries and Aquaculture (SOFIA) 2006. FAO. Rome, 2007. 162 p. http://www.fao.org/docrep/009/A0699e/A0699E06.htm#6.2

FAO. 2008. Report of the FAO Expert Workshop on Climate Change Implications for Fisheries and Aquaculture. Rome, Italy, 7–9 April 2008. FAO Fisheries Report No. 870. 32 p.

Soto, D., Aguilar-Manjarrez, J. and Hishamunda, N. (eds). 2008. *Building an ecosystem approach to aquaculture*. FAO/Universitat de les Illes Balears Expert Workshop. 7-11 May 2007, Mallorca Spain. FAO Fisheries Proceedings No. 14 (in press).

SPADA -The Special Programme for Aquaculture Development in Africa[1] Selected Highlights

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FAN 39 featured an article on SPADA, the FAO Fisheries and Aquaculture (FI) Department's Special Programme on Aquaculture Development in Africa (Moehl *et al.*, 2008) which at the same time constitutes the aquaculture component of the FAO FI's Strategy for Fisheries and Aquaculture in Africa (FISA). It described some of the history and background of the programme; outlining the programme's aims, structure and the seven arenas where SPADA is planned to be active in congruence with the New Partnership for Africa's Development (NEPAD) Action Plan for the development of fisheries and aquaculture. Given the relevance of SPADA to building momentum for investment in aquaculture in Africa, this follow-up article takes a closer look at each of the individual arenas and explores how the current field programme (FAO's Technical Cooperation Projects (TCP)), Unilateral Trust Funds (UTF) and extra-budgetary funded projects) addresses these issues. The list is not meant to be exhaustive but rather aims at providing insight into working examples and approaches in the field.

Selected ongoing activities in SPADA arenas

(i) Strengthening institutions and enabling frameworks

SPADA will support national fora and stakeholder consultations that will lead to national aquaculture development strategies, plans and adjusted legal frameworks that enable increased investment and trade within the aquaculture sub-sector. Further, the programme will provide capacity building and advice as to how to efficiently structure aquaculture institutions at all levels including training on a broad spectrum of issues such as aqua-business management, production, aquaculture facilities siting and development, risk assessment and communication.

FAO has supported, and continues to support, the processes to develop national aquaculture development strategies and plans in many African countries including but not limited to Cameroon, The Gambia, Madagascar, Namibia, Nigeria, Tanzania, and Uganda. Cameroon requested the support of FAO for developing the first national strategy. This benchmark document, formulated in May 2003 by a team of experts representing government agencies, World Fish Center and FAO, was subsequently discussed in stakeholder consultations before being adopted in December 2003. A second request for assistance in the implementation of the strategy is being achieved through TCP/CMR/3103 *Mise en place d'un plan de développement durable de l'aquaculture*). Efforts are continuing to reach as many countries as possible and feasible with existing resources. A key partner in this process is the Japanese-funded *GCP/INT/053/JPN Intra African Training and Dissemination of Technical Know-How for Sustainable Agriculture and Rural development with Africa-ASEAN Cooperation within the Framework of South-South Cooperation* which has capacity building for African aquaculture development under the framework of SPADA as one of its four main focal areas. Through TCP/RAF/3111 *Emergency assistance to combat epizootic ulcerative syndrome in the Chobe-Zambesi River* (involving Angola, Botswana, Malawi, Mozambique, Namibia, Zambia, Zimbabwe) and the PCA Norway-funded project on aquatic animal health and aquatic biosecurity, FAO continues to provide capacity building aimed at

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