



منظمة الأغذية  
والزراعة  
للأمم المتحدة

联合国  
粮食及  
农业组织

Food  
and  
Agriculture  
Organization  
of  
the  
United  
Nations

Organisation  
des  
Nations  
Unies  
pour  
l'alimentation  
et  
l'agriculture

Продовольственная и  
сельскохозяйственная  
организация  
Объединенных  
Наций

Organización  
de las  
Naciones  
Unidas  
para la  
Agricultura  
y la  
Alimentación

## COMMITTEE ON FISHERIES

### Twenty-eighth Session

Rome, Italy, 2 – 6 March 2009

## CLIMATE CHANGE AND FISHERIES AND AQUACULTURE

### INTRODUCTION

1. The 27<sup>th</sup> Session of the Committee on Fisheries (COFI), 5-9 March 2007, raised the issue of climate change under three agenda items. In discussing the “Decisions and recommendations of the third session of the COFI Sub-committee on Aquaculture”, some Members requested further work by FAO on the impact of climate change in aquaculture (para. 51). Under the Agenda item on “Social issues in small-scale fisheries” it was noted that cross-sectoral policies were needed for small-scale fisheries that recognized ecosystem considerations, anticipated potential climate change impacts and were guided by Article 10 of the Code of Conduct on the integration of fisheries into coastal area management (para.60). Most significantly, in discussing “Implementing the ecosystem approach to fisheries, including deep-sea fisheries, marine debris and lost and abandoned gear”, the Committee raised the need to address threats posed by climate change and “There was support for a proposal that FAO should undertake a scoping study to identify the key issues on climate change and fisheries, initiate a discussion on how the fishing industry can adapt to climate change, and for FAO to take a lead in informing fishers and policy makers about the likely consequences of climate change for fisheries” (para. 76).

2. Later in 2007, the Inter-Governmental Panel on Climate Change (IPCC) released the Working Group Reports for its 4<sup>th</sup> Assessment Report<sup>1</sup> which contained far reaching conclusions on the current and projected trends in global warming and the likelihood that anthropogenic influences were major drivers of climate change. Amongst the conclusions were that “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level” and that “There is high agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades.” The 4<sup>th</sup> Assessment Report therefore left no doubt that adaptation to climate change and actions to mitigate greenhouse gas (GHG) emissions must be addressed with urgency.

<sup>1</sup> Climate Change 2007: Synthesis Report. Summary for Policymakers. An Assessment of the Intergovernmental Panel on Climate Change. [http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4\\_syr\\_spm.pdf](http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf) accessed 9 November 2008.

## FI AND FAO ACTIVITIES ON CLIMATE CHANGE

### i) *Expert Workshop on Climate Change Implications for Fisheries and Aquaculture*

3. In response to the request from the 27<sup>th</sup> Session of COFI that FAO should undertake a scoping study to identify the key issues on climate change and fisheries and with additional impetus and some financial support from the preparations for the FAO High-Level Conference on World Food Security: The Challenges of Climate Change and Bioenergy (see below), the Fisheries and Aquaculture Department (FI) held an Expert Workshop on “Climate Change Implications for Fisheries and Aquaculture”, from 7 to 9 April 2008. As background for the workshop, three comprehensive technical reviews were prepared by leading authorities in the field. These will be published in an FAO Fisheries Technical Paper<sup>2</sup>. The report of the workshop has been published in English as FAO Fisheries Report. No. 870<sup>3</sup>. The Conclusions and Recommendations from that Report are included in this document as Annex 1 and are summarised below under the heading Issues and Options. In addition, two other documents were produced by the Workshop as input to the High Level Conference: “Options for Decision Makers”<sup>4</sup> and a “Technical Background Document”<sup>5</sup>.

### ii) *High-Level Conference on World Food Security: the Challenges of Climate Change and Bioenergy*

4. The High-Level Conference on “World Food Security: The Challenges of Climate Change and Bioenergy” was held at FAO Headquarters from 3-5 June 2008. One hundred and eighty-one member countries participated, including forty-two Heads of State and Government, one hundred Ministers and representatives from sixty non-governmental and civil society organizations. In preparation for the Conference a series of Expert Meetings was held including that on fisheries and aquaculture. Details on these workshops and their reports can be obtained from <http://www.fao.org/foodclimate/expert/en/>.

5. The Conference adopted a Declaration by acclamation which included the following paragraph with direct reference to fisheries, which here implicitly includes aquaculture:

6. “The current crisis has highlighted the fragility of the world’s food systems and their vulnerability to shocks. While there is an urgent need to address the consequences of soaring food prices, it is also vital to combine medium and long-term measures, such as the following:

(...)

- a) It is essential to address the fundamental question of how to increase the resilience of present food production systems to challenges posed by climate change. In this context, maintaining biodiversity is key to sustaining future production performance. We urge governments to assign appropriate priority to the agriculture, forestry and fisheries sectors, in order to create opportunities to enable the world’s smallholder farmers and fishers, including indigenous people, in particular in vulnerable areas, to participate in, and benefit from financial mechanisms and investment flows to support climate change adaptation, mitigation and technology development, transfer and dissemination.”

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<sup>2</sup> The three papers are “Physical and ecological impacts of climate change relevant to marine and inland capture fisheries and aquaculture” by Manuel Barange and Ian Perry; “Climate change and capture fisheries: impacts, adaptation, mitigation, and the way forward” by Tim Daw, Neil Adger, Katrina Brown and Marie-Caroline Badjeck; and “Climate change and aquaculture: impacts, adaptation, mitigation, and the way forward” by Sena De Silva and Doris Soto

<sup>3</sup> 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. Rome, FAO. 2008. 32p.

<sup>4</sup> [http://www.fao.org/fileadmin/user\\_upload/foodclimate/presentations/fish/OptionsEM7.pdf](http://www.fao.org/fileadmin/user_upload/foodclimate/presentations/fish/OptionsEM7.pdf)

<sup>5</sup> [http://www.fao.org/fileadmin/user\\_upload/foodclimate/HLCdocs/HLC08-bak-6-E.pdf](http://www.fao.org/fileadmin/user_upload/foodclimate/HLCdocs/HLC08-bak-6-E.pdf)

iii) *Scientific Symposium on Coping with Global Change in Marine Social-Ecological Systems*

7. This international, scientific symposium was held at FAO, Rome, 8-11 July 2008, and was co-organized by the Global Ocean Ecosystem Dynamics (GLOBEC) programme, the European Network of Excellence for Oceans Ecosystem Analysis (EUR-OCEANS) and FAO. The symposium presented an opportunity for scientists and practitioners to share experiences and to identify common elements and approaches that promote resilience of marine social-ecological systems in the face of global changes. The Symposium considered a number of broad issues such as: social-ecological responses in marine systems to global changes; analyzing case studies of social-ecological responses in marine systems to environmental changes; developing innovative approaches to the use of science and knowledge in management, policy and advice; and identifying lessons for governance for building resilient social-ecological systems. No formal conclusions were arrived at but the proceedings of the Symposium will be published in the form of a series of papers.

iv) *Project Development*

8. FI is also actively exploring options for increasing its technical support to Members on climate change implications for fisheries and aquaculture, in cooperation with other relevant agencies. A key activity in this regard is an informal coordination meeting that is being organized jointly with the World Bank and WorldFish Centre. The goal of the meeting, scheduled for March 2009, is to provide an opportunity for those international organizations and agencies leading initiatives on the threats of climate change to fisheries and aquaculture to discuss their work programmes and plans and agree on means to improve coordination and cooperation. The outputs of the meeting could include a framework for a Global Programme on climate change adaptation and mitigation in fisheries and aquaculture for consideration by countries and which could be used by all organizations, individually and in partnership, to help in the development of future initiatives.

9. In addition, a project proposal has been submitted to one donor and a decision is being awaited. The project will address "Reduced vulnerability of fishing and fish farming communities to natural disasters" and is aimed at improving the resilience and preparedness of countries and communities to reduce vulnerability of fishing and fish farming communities to natural and other disasters, including species introductions, fish disease epizootics, and climate change. It is intended to address both short and long-onset disasters, including climate change. Other proposals may be prepared and submitted in the future depending on requests from donor and recipient countries and the on-going priority given to climate change by COFI.

## **ISSUES AND OPTIONS**

10. This section briefly summarizes some of the major conclusions and recommendations arrived at by the above-mentioned Expert Workshop "Climate Change Implications for Fisheries and Aquaculture", which was held in April 2008.

11. Climate change is projected to impact broadly across ecosystems, societies and economies, increasing pressures on all livelihoods and food supplies, including those in the fisheries and aquaculture sector. The sector differs from mainstream agriculture, and has distinct interactions and needs with respect to climate change. The demands of growing populations will require substantial increases in aquatic food supply in the next 20 to 30 years, during which period climate change impacts are expected to widen and increase.

12. Climate change is modifying the distribution of marine and freshwater species. In general, species are being displaced towards the poles and are experiencing changes in the size and productivity of their habitats and seasonality of biological processes. Sea level rise, glacier melting, ocean acidification and changes in precipitation, groundwater and river flows will significantly affect many ecosystems including coral reefs, wetlands, rivers, lakes and estuaries.

13. Changes in productivity, distribution, species composition and habitats will require changes in fishing practices and aquaculture operations, as well as in the location of operations, landing, and processing facilities. Extreme events will also impact on infrastructure, ranging from farming and landing sites to post-harvest facilities and transport routes. They will also affect safety at sea and settlements, with communities living in low-lying areas at particular risk. Water stress and competition for water resources will affect aquaculture operations and inland fisheries production, and are likely to increase conflicts among water-dependent activities. Reduced livelihood options inside and outside the fishery sector will force occupational changes and may increase social pressures. These impacts will have particular gender dimensions which also need to be considered.

14. Climate change will have potentially significant impacts on the four dimensions of food security: *availability* of aquatic foods will vary through changes in habitats, stocks and species distribution; *stability* of supply will be impacted by changes in seasonality, increased variance in ecosystem productivity and increased supply variability and risks; *access* to aquatic foods will be affected by changes in livelihoods and catching or farming opportunities; *utilization* of aquatic products will also be impacted and, for example, some societies and communities will need to adjust to species not traditionally consumed.

15. Greenhouse gas contributions of fisheries, aquaculture and related supply chain features are small when compared with other sectors but, nevertheless can be improved, with identifiable measures already available. Options for mitigation measures lie primarily in energy consumption, through fuel and raw material use, though as with other food sectors, management of distribution, packaging and other supply chain components will also contribute to decreasing the sector's carbon footprint.

16. The need for adaptation is a feature of all livelihoods dependent on natural resource utilization but projected climate change poses multiple additional risks to fishery dependent communities. Adaptation strategies will need to be context and location specific and to consider impacts both short-term (e.g. increased frequency of severe events) and long-term (e.g. reduced productivity of aquatic ecosystems). Options to increase resilience and adaptability include the adoption, as standard practice, of adaptive and precautionary management within an ecosystem approach to fisheries (EAF) and to aquaculture (EAA) management. In the face of more frequent severe weather events, strategies for reducing vulnerabilities of fishing and fish farming communities have to address measures including: investment and capacity building on improved forecasting; early warning systems; safer harbours and landings; and safety at sea. National climate change adaptation and food security policies and programmes need to fully integrate the fisheries and aquaculture sector.

17. The Workshop agreed on a list of far-reaching recommendations for national, regional and international action (see Annex 1). These included:

- **Developing the knowledge base.** In the future, planning for uncertainty will need to take into account the greater possibility of unforeseen events, such as the increasing frequency of extreme weather events and other “surprises”. However, examples of past management practices under variability and extreme events can still provide useful lessons to design robust and responsive adaptation systems. Improved knowledge in a number of areas will be valuable e.g. projections of future fish production level, detailed impact predictions on specific fisheries and aquaculture systems, improved tools for decision-making under uncertainty, and improved knowledge of who is or will be vulnerable with respect to climate change and food security impacts and how they can be addressed.
- **Policy, legal and implementation frameworks.** Addressing the potential complexities of climate change interactions and their possible impacts requires mainstreaming of cross-sectoral responses into governance frameworks. Action plans

at the national level can have as their bases the Code of Conduct for Responsible Fisheries and related International Plans of Action (IPOAs), as well as appropriately linked policy and legal frameworks and management plans. Links will be required among national climate change adaptation policies and programmes as well as cross-sectoral policy frameworks such as those for food security, poverty reduction, emergency preparedness and others. The potential for spatial displacement of aquatic resources and people as a result of climate change impacts will require existing regional structures and processes to be strengthened or given more specific focus. Internationally, sectoral trade and competition issues are also likely to be impacted by climate change.

- **Capacity building: technical and organizational structures.** Policy-making and action planning in response to climate change involves not only the technically concerned agencies, such as departments responsible for fisheries, interior affairs, science, and education, but also those for national development planning and finance. These institutions, as well as community or political representatives at subnational and national level should also be identified to receive targeted information and capacity building. Partnerships would also need to be built and strengthened among the public, private, civil society and NGO sectors.
  
- **Enabling financial mechanisms: embodying food security concerns in existing and new financial mechanisms.** The full potential of existing financial mechanisms, such as insurance, at national and international levels will be needed to tackle the issue of climate change. Innovative approaches may also be needed to target financial instruments and to create effective incentives and disincentives. The public sector will have an important role in leveraging and integrating private sector investment interacting through market mechanisms to meet sectoral aims for climate change response and food security. Many of these approaches are new and will need to be tested in the sector.

#### **FOR DISCUSSION BY COFI**

18. The 28th Session of COFI is invited to:
  - a. Consider and discuss the likely impacts of climate change for fisheries and aquaculture, potential responses to those changes and their implications for FAO Member States.
  - b. Comment on the major conclusions and recommendations from the Expert Workshop on “Climate Change Implications for Fisheries and Aquaculture”.
  - c. Provide recommendations and guidance on future activities to be undertaken by FI.

## ANNEX 1

**Conclusions and Recommendations of the FAO Expert Workshop on “Climate Change Implications for Fisheries and Aquaculture”<sup>6</sup>****CONCLUSIONS AND RECOMMENDATIONS**

9. After extensive discussion, the Workshop agreed on the following conclusions, summarizing the current state of knowledge on fisheries and climate change, and recommendations. A more detailed synopsis of predicted climate change impacts and measures for mitigation and adaptation within the fisheries and aquaculture sector is attached to this report as Appendix D.

**Introduction**

10. From the local to global levels, fisheries and aquaculture have a very important role for food supply, food security and income generation. Some 42 million people work directly in the sector, with the great majority in developing countries. Adding those who work in processing, marketing, and distribution and supply industries, the sector supports several hundred million livelihoods. Aquatic foods have high nutritional quality, contributing 20 percent or more of average per capita animal protein intake for more than 2.8 billion people, mostly from developing countries. Aquatic foods are the most widely traded foodstuffs and are essential components in export earnings for many poorer countries. The sector has particular significance for small island states.

11. Climate change is projected to impact broadly across ecosystems, societies and economies, increasing pressures on all livelihoods and food supplies, including those in the fisheries and aquaculture sector. Food quality will have a more pivotal role as food resources come under greater pressure, and the availability and access to fish supplies will become an increasingly critical development issue.

12. The sector differs from mainstream agriculture, and has distinct interactions and needs with respect to climate change. Capture fisheries have unique features of natural resource harvesting linked with global ecosystem processes. Aquaculture complements and increasingly adds to supply, and, though more similar to agriculture in its interactions, has important links with capture fisheries.

13. The demands of growing populations will require substantial increases in aquatic food supply in the next 20 to 30 years, during which period climate change impacts are expected to widen and increase. The primary challenge for the sector will be, in the face of these impacts and the existing development and management constraints, to deliver food supply, strengthen economic output and maintain and enhance food security; while ensuring ecosystem resilience. This will require concerted, collaborative and determined action across all stakeholders, linking private sector, community and public sector agents.

**Summary of the dimensions and scales of likely climate change impacts on fisheries and aquaculture including livelihoods of fishing and fish farming communities**

14. Climate change is a compounding threat to the sustainability of capture fisheries and aquaculture development. Impacts occur as a result of both gradual warming and associated physical changes as well as from frequency, intensity and location of extreme events, and take place in the context of other global socio-economic pressures on natural resources. Urgent adaptation measures are required in response to opportunities and threats to food and livelihood provision due to climatic variations.

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<sup>6</sup> Excerpts from: 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. Rome, FAO. 2008. 32p.

### ***Ecosystem impacts***

- Climate change is modifying the distribution of marine and freshwater species. In general, species are being displaced towards the poles and are experiencing changes in the size and productivity of their habitats. This provides challenges but also opportunities.
- In a warmed world, ecosystem productivity is likely to be reduced in most tropical and subtropical oceans, seas and lakes and increased in high latitudes. Increased temperatures will affect fish physiological processes resulting in both positive and negative effects on fisheries and aquaculture systems.
- Climate change is already affecting the seasonality of particular biological processes, radically altering marine and freshwater food webs, with unpredictable consequences for fish production. Increased risks of species invasions and spreading of vector-borne diseases provide additional concerns.
- 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.
- 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 minimise impacts on fisheries and aquaculture systems.

### ***Impacts on livelihoods***

- Changes in distribution, species composition and habitats will require changes in fishing practices and aquaculture operations, as well as in the location of landing, farming and processing facilities.
- Extreme events will also impact on infrastructure, ranging from landing and farming sites to post-harvest facilities and transport routes. They will also affect safety at sea and settlements, with communities living in low-lying areas at particular risk.
- Water stress and competition for water resources will affect aquaculture operations and inland fisheries production, and are likely to increase conflicts among water-dependent activities.
- Livelihood strategies will have to be modified for instance with changes in fishers migration patterns due to changes in timing of fishing activities.
- Reduced livelihood options inside and outside the fishery sector will force occupational changes and may increase social pressures. Livelihood diversification is an established means of risk transfer and reduction in the face of shocks, but reduced options for diversification will negatively affect livelihood outcomes.
- There are particular gender dimensions, including competition for resource access, risk from extreme events and occupational change in areas such as markets, distribution and processing, in which women currently play a significant role.

### ***Implications for food security***

15. Climate change will have potentially significant impacts on the four dimensions of food security, with changes as follows.

*Availability* of aquatic foods will vary, positively and negatively, through changes in habitats, stocks and species distribution. These changes will occur at local and regional levels in inland, coastal and marine systems, due to aquatic ecosystem shifts and impacts on aquaculture.

*Stability* of supply will be impacted by changes in seasonality, increased variance of ecosystem productivity, increased supply risks and reduced supply predictability – issues that may also have large impacts on supply chain costs and retail prices.

*Access* to aquatic foods will be affected by changes in livelihoods and catching or culture opportunities combined with transferred impacts from other sectors (i.e. increased prices of substitute foods), competition for supply, and information asymmetries. Impacts may also arise from rigid management measures that control temporal and spatial access to resources.

*Utilization* of aquatic products and the nutritional benefits produced will be impacted by: changes in range and quality of supply; market chain disruptions; greater food safety issues; and reduced opportunities to consume preferred products. This is particularly critical for countries with high per capita fish consumption.

16. Food security will also be positively affected by increasing the percentage of fish used for direct human consumption (versus fish used for feed) and reducing post-harvest losses through spoilage and waste. Climate change will add to the complexity of addressing these issues and climate events may have a direct negative impact on the control of spoilage and waste.

#### **Summary of achievable climate change mitigation measures**

17. The primary mitigation route for the sector lies in its energy consumption, through fuel and raw material use, though as with other food sectors, management of distribution, packaging and other supply chain components will also contribute to decreasing the sector's carbon footprint.

- Greenhouse gas contributions of fisheries, aquaculture and related supply chain features are small when compared with other sectors but, nevertheless can be improved, with identifiable measures already available. In many instances, climate change mitigation could be complementary to and reinforce existing efforts to improve fisheries and aquaculture sustainability (e.g. reducing fishing effort and fleet capacity in order to reduce energy consumption and carbon emissions).
- Technological innovations could include energy reduction in fishing practices and aquaculture production and more efficient post-harvest and distribution systems. There may also be valuable interactions for the sector with respect to environmental services (e.g. maintaining the quality and function of coral reefs, coastal margins, inland watersheds), and potential carbon sequestration and other nutrient management options, but these will need further research and development (R&D). The sustainable use of genetic diversity, including through biotechnologies, could have particular efficiency impacts (e.g. through widening production scope of low-impact aquaculture species, or making agricultural crop materials or waste products usable for growing carnivorous aquatic species) but would require to be evaluated on wider social, ecological and political criteria.
- Mitigation R&D expenditure will need to be justified clearly by comparison with other sectors whose impacts could be much greater, but policy influence could already be used to support more efficient practices using available approaches.
- Possible negative impacts of mitigation on food security and livelihoods would have to be better understood, justified where relevant, and minimized.

#### **Summary of key climate change adaptation measures**

18. Although resource-dependent communities have adapted to change throughout history, projected climate change poses multiple additional risks to fishery dependent communities that might limit the effectiveness of past adaptive strategies. Adaptation strategies will require to be context and location specific and to consider impacts both shortterm (e.g. increased frequency of severe events) and long-term (e.g. reduced productivity of aquatic ecosystems). All three levels of adaptation (community, national and regional) will clearly require and benefit from stronger capacity building, through awareness raising on climate change impacts on fisheries and aquaculture, promotion of general education, and targeted initiatives in and outside the sector.



- Options to increase resilience and adaptability through improved fisheries and aquaculture management include the adoption as standard practice of adaptive and precautionary management. The ecosystem approaches to fisheries (EAF) and to aquaculture (EAA) should be adopted to increase the resilience of aquatic resources ecosystems, fisheries and aquaculture production systems, and aquatic resource-dependent communities.
- Aquaculture systems, which are less or non-reliant on fishmeal and fish oil inputs (e.g. bivalves and macroalgae), have better scope for expansion than production systems dependent on capture fisheries commodities.
- Adaptation options also encompass diversification of livelihoods and promotion of aquaculture crop insurance in the face of potentially reduced or more variable yields.
- In the face of more frequent severe weather events, strategies for reducing vulnerabilities of fishing and fish farming communities have to address measures including: investment and capacity building on improved forecasting; early warning systems; safer harbours and landings; and safety at sea. More generally, adaptation strategies should promote disaster risk management, including disaster preparedness, and integrated coastal area management.
- National climate change adaptation and food security policies and programmes would need to fully integrate the fisheries and aquaculture sector (and, if non-existent, should be drafted and enacted immediately). This will help ensure that potential climate change impacts will be integrated into broader national development (including infrastructure) planning.
- Adaptations by other sectors will have impacts on fisheries, in particular inland fisheries and aquaculture (e.g. irrigation infrastructure, dams, fertilizer use runoff), and will require carefully considered trade-offs or compromises.
- Interactions between food production systems could compound the effects of climate change on fisheries production systems but also offer opportunities. Aquaculture based livelihoods could for example be promoted in the case of salination of deltaic areas leading to loss of agricultural land.

## RECOMMENDATIONS

### Developing the knowledge base

19. The existing pressures of demand, and anticipated challenges, will require better multiscale understanding of the impacts of climate change and of the interacting contribution of fisheries and aquaculture to food and livelihoods security. Climate change will increase uncertainties in the supply of fish from capture and culture. Such uncertainty will impose new challenges for risk assessment, which is commonly based on knowledge of probabilities from past events. Data for determining effects of past climate change at best cover no more than a few decades, and may no longer be an adequate guide to future expectations.

20. This means that, in the future, planning for uncertainty will need to take into account the greater possibility of unforeseen events, such as the increasing frequency of extreme weather events and “surprises”. However, at the same time, examples of past management practices in response to existing climate variability and extreme events relating to different regions and resources can provide useful lessons to design robust and responsive adaptation systems, even though they will have to be placed in context of greater uncertainty.

21. While current knowledge is adequate in many instances to take appropriate action, better communication, application and feedback will be essential in knowledge-building. Action in the following areas will be needed to support mitigation and adaptation policies and programmes in fisheries and aquaculture:

*Estimate production levels.* Projections of future fisheries production levels at the global and regional scales will be driven by medium- and long-term probabilistic climate change predictions in the context of substantial ecological and management uncertainties.

*Forecast impact levels.* Detailed impact predictions on specific fisheries and aquaculture systems will be required to determine additional positive or negative consequences for vulnerable resources and regions. This is particularly important for semi-arid countries with significant coastal or inland fisheries, as they are among the most vulnerable to climate change.

*Develop tools for decision-making under uncertainty.* Adaptive tools for the fisheries and aquaculture sectors will need to be refined, developed and implemented to guide decisionmaking under uncertainty and address important cross linkages among the relevant sectors. The uncertainties decision-makers will face include: i) the responses and adaptations of marine and freshwater production systems to gradual climate change, including critical thresholds and points of no return; ii) the synergistic interactions between climate change and other stressors such as water use, eutrophication, fishing, agriculture, alternative energy; and iii) the ability and resilience of aquatic production systems and related human communities to adapt and cope to multiple stresses.

*Expand societal knowledge.* Better knowledge will be required of who is or will be vulnerable with respect to climate change and food security impacts, how this arises and how it can be addressed. In this regard, gender and equity issues will need to be carefully considered.

### **Policy, legal and implementation frameworks at national, regional and international levels**

22. Addressing the potential complexities of climate change interactions and their possible scale of impact requires mainstreaming of cross-sectoral responses into governance frameworks. Responses are likely to be more timely, relevant and effective if they are brought into the normal processes of development and engage people and agencies at all levels. This requires not only the recognition of climate-related vectors and processes, and their interaction with others, but also availability of sufficient information for effective decisionmaking and approaches that engage public and private sectors. All of these elements will be vital in providing the best possible conditions in which the aims of food security – quantity and timing of food supply, access and utilization – can be met.

*National.* Action plans at the national level can have as their bases the Code of Conduct for Responsible Fisheries and related International Plans of Action (IPOAs), as well as appropriately linked policy and legal frameworks and management plans. Responses will need to employ integrated ecosystem-based approaches to fisheries and aquaculture (EAFs and EAAs) for the national fisheries and aquaculture sector throughout the entire resource extraction, supply and value chain. The future implications of climate change will intensify the justification for finding policy consensus to reform capture fisheries while respecting national sector characteristics.

- Actions will be needed that focus on key issues such as adjusting fleet and infrastructure capacity and flexibility, identifying management systems that offer negotiated balances between efficiency and access, and creating alternative employment and livelihood opportunities.
- Policy and legal regulatory frameworks will be required for aquaculture to expand along sustainable and equitable development paths.
- Links will need to be improved among fisheries, aquaculture and other sectors that share or compete for resources, production processes or market position, in order to manage conflicts and ensure that food security aims can be maintained.
- Links will be required among national climate change adaptation policies and programmes as well as national cross-sectoral policy frameworks such as those for food security, poverty reduction, emergency preparedness and response, insurance and social safety schemes, agricultural and rural development, and trade policies.

*Regional.* The potential for spatial displacement of aquatic resources and people as a result of climate change impacts, and the greater variability characteristics of transboundary resources will require existing regional structures and processes to be strengthened or given more specific focus. Policy and legal mechanisms that address these issues will need to be developed or enhanced.

Regional market and trading mechanisms are also likely to be more important in linking and buffering supply variability and maintaining sectoral value and investment.

- Regional fisheries organizations and other regional bodies should be strengthened. They should place climate change awareness and response preparedness clearly on their agendas and link more closely with related regional bodies.
- Fisheries and aquaculture will need to be addressed adequately in cross-sectoral and transboundary resource use planning and in intraregional markets and trade. In this vein, the potential effects of climate change stressors on regional issues will have to be considered as part of any provisions for action.
- Common platforms are needed for research and data gathering approaches, sharing of best practices in identifying and responding to climate change-related impacts and developing response mechanisms.

*International.* As sectoral trade and competition issues link with climate change mitigation and adaptation activities, they are likely to become more important, with the potential to define many areas of economic potential and constraint. As a small and often politically weak sector, fisheries and aquaculture may be particularly vulnerable in such competition and conflicts. This increases the importance of having fishery sector representation in policy and legal development processes related to climate change mitigation and adaptation.

- Fisheries and aquaculture need to be adequately addressed in climate change policies and programmes dealing with global commons, food security and trade.
- Common platforms are needed for international data and research approaches, sharing best practices in identifying and responding to climate change-related impacts and developing response mechanisms.
- Fishery sector responses should be incorporated into processes and decisions related to climate change in the other major sectors (e.g. water) to which fishery issues are linked.
- International fishery agreements and conventions should be more vigorously applied, and strengthened if necessary, to accommodate and support climate change-related activities.
- Cooperation and partnerships should be enhanced for dealing with NGOs, civil society organizations, intergovernmental organizations, including the one-UN approach, and donor coordinated initiatives.

### **Capacity building: technical and organizational structures**

23. Policy-making and action planning in response to climate change involves not only the technically concerned line agencies, such as departments responsible for fisheries, interior affairs, science, and education, but also those for national development planning and finance. These institutions, as well as community or political representatives at subnational and national level should also be identified to receive targeted information and capacity building. Partnerships would also need to be built and strengthened among the public, private, civil society and NGO sectors.

- Nationally, information gaps and capacity building requirements will have to be identified and addressed through networks of research, training and academic agencies
- Internationally, networks should be created or developed to encourage and enable regional or global exchange of information and experience, linking fishery sector issues with others including water management, community development, trade and food security.
- Existing management plans for the fisheries and aquaculture sector, coastal zones or watersheds should be reviewed and, if needed, developed to ensure that they cover potential climate change impacts, mitigations and adaptation responses. Connections with wider planning and strategic processes also need to be identified and adjusted.

- Communication and information processes that reach all stakeholders will be essential elements in sectoral response. This will require focused application by communication specialists to ensure that the information is accessible and usable – presenting diverse and complex issues in a form that is targeted and understandable for specific audience.

**Enabling financial mechanisms: embodying food security concerns in existing and new financial mechanisms**

24. The full potential of existing financial mechanisms will be needed to tackle the issue of climate change. Innovative approaches may also be needed to target financial instruments and to create effective incentives and disincentives. The public sector will have an important role in leveraging and integrating private sector investment interacting through market mechanisms to meet sectoral aims for climate change response and food security. Many of these approaches are new and will need to be tested in the sector.

*At the national level:*

- Producers, distributors and processors should be able to increase self protection through financial mechanisms. This is particularly relevant for aquaculture (e.g. cluster insurance) but financial services could also be used to promote emergency funds more widely through the sector.
- Investment in the sector, especially in infrastructure, will need to consider climate change, which will require developing better information on the costs and benefits of protection.
- Transfer or spread of sector-related risk – from individuals and communities to the state through contingency plans – will be based on specific fiscal provisions but also may be tied to innovations in resource management through which the insured accept responsibilities in exchange for protection.
- Financial instruments that can promote risk reduction and prevention practices include initiatives such as relocation allowances from low lying areas and disincentives for misuse of water in aquaculture.
- Existing and new initiatives for improving equity and economic access, such as microcredit, should be linked to climate change adaptation responses such as livelihood diversification.
- Mitigation options can include fiscal incentives for reducing the sector's carbon footprint, developing more efficient processes and sector agreements, and providing payment for environmental services, particularly offering additional livelihood options to poorer communities.

*At the international level:*

- Funding agencies can “climate proof” their approaches and, at the same time, take advantage of new opportunities in the fisheries and aquaculture sector by jointly promoting food security, reducing negative impacts of climate variability and change, and improving resource management.
- Donors should be made more aware of the importance of the fisheries and aquaculture sector in terms of food security and its sensitivity to climate change, and of effective ways in which the sector could become part of cross-sectoral investment strategies.
- Private sector investors should be encouraged to incorporate “climate proof” approaches into international sourcing, trade and market development, and into broader corporate responsibility areas, including delivery of local benefits and inclusion of smaller scale producers.