

## 7. VULNERABILITY OF FISHERIES TO CLIMATE CHANGE AND NATURAL DISASTERS

The annual cycles of the monsoon is key to both terrestrial and marine natural resources productivity in Southeast Asia. The seasonal monsoon and related variations in the climate, hydrological, and oceanographic patterns are important for the life-cycle of aquatic resources. However, climate variability and climate change combined with unusual and unpredictable seasonal weather patterns are increasingly affecting the livelihoods of people dependent on fisheries and aquatic resources. This should be seen in the perspective of, as emphasized in the SEASOFIA issued in 2012 (SEAFDEC, 2012b), capture fisheries and aquaculture which are among the most important livelihood sources available to coastal communities. The same goes for communities living in the watersheds and floodplains of the region with its abundance and diversity in fisheries and other aquatic resources and plants.

The sustainability of these resources continues to be subject to various threats and pressures and important habitats and biodiversity are threatened by environmental degradation and destructive fishing. Overfishing in the region is a problem leading to the reduced availability of fishery products. Erosion is also a serious problem and the construction of dams and roads, for example, in and around watersheds, is impacting the connectivity of river floodplain systems, affecting the migration and spawning of many fish species. As a result, the livelihoods of many inland and coastal communities are threatened.

Adding to the threats from environmental degradation and overexploitation, smaller villages in coastal and inland areas throughout the region are facing increased hardships due to the impact of natural hazards such as storms, tornados, floods, drought, and so on. Lessons learned from disasters and efforts to adapt to climate variability should be incorporated into plans to, given the specific geographical location, integrate fisheries management into habitat management, and coastal and inland resources management. This could include safety and rescue at sea, records of available vessels to be kept, efforts to ensure connectivity and migration paths, and many more. This should also include efforts to build resilience, incorporate local knowledge in adaptation plans, and to restore important and protective coastal and inland features, wetlands, and habitats throughout the Southeast Asian region.

The situation, with the need to reverse environmental degradation and to implement climate related mitigation measures, is very much the same as that explained in SEAFDEC (2012b). In this connection, the argument on climate related concerns builds upon and summarizes

the earlier text with emphasis given on environmental degradation, overexploitation, and impacts of climate variability and climate change, as seen in combination and in many cases considered as climate change impacts that add as “stressor” to existing problems.

It is important and urgent to integrate fisheries management into marine and terrestrial spatial planning and subsequent resource exploitation with the objective of ensuring sustainable utilization of important resources, protecting vulnerable areas and species, and thereby mitigating the impacts of climate variability and climate change while promoting adaptation at community level. In particular, strategies and interventions to mitigate the effects of climate change to the fisheries industry should be established. Environment friendly strategies to lessen the sectors’ impacts on the environment should also be developed, which pertains to the efforts to reduce the carbon footprint of fisheries. These efforts should be taken with serious deliberation considering that many people in the Southeast Asian region are increasingly dependent, directly or indirectly, on the fishery resources as proven in the per capita consumption that reached a new all-time high (FAO, 2010).

### 7.1 Vulnerability of Coastal and Inland Communities and Impacts on Important Habitats

The Southeast Asian region has been considered as one of the areas where rural or coastal people are most vulnerable to environmental variations caused by climate change (and environmental degradation) because of its long coastlines, extensive floodplains, and dependence on seasonal monsoon patterns that trigger the productivity and availability of fisheries and other aquatic resources as the main source of sustenance for many coastal dwellers and inland communities (IPCC, 2007 as cited by Santos *et al.*, 2011). The vulnerability of people and habitats should not only be viewed from the perspective of the normal fluctuations in the common seasonal monsoon variability with shorter or longer wet or dry seasons but also, and increasingly so in the perspective of longer term climate change that may threaten to further expose the already vulnerable coastal and inland fishing communities by more persistent changes in the monsoon pattern. It is widely recognized that the effects of climate change include seasonal monsoon or rainfall variations, increased and stronger incidence of storms and typhoons, changes in the patterns and peaks in dry and wet season fluctuations, increased land-based run-offs, and rise in sea-surface and shallow lake temperature. The effects highly influence the productivity of the coastal and inland habitats and the availability of fishery and aquatic resources.

In coral reef ecosystem, sea surface temperature rise is the main factor which has the most direct adverse effect as manifested in massive coral bleaching that started in 1998 and followed by subsequent similar events throughout the region up to the present. Similarly, climate-related effects on mangroves will be highly manifested due to sea level rise as well as the frequency and intensity of strong surges. Sea level rise will have direct impact on these habitats and will dictate mangrove landward migration (Gilman *et al.*, 2007). In addition, the clearance of mangroves for urban and industrial development, shrimp farming and other uses, leaves coastal villages more exposed to natural hazards and climate change and may even result in them being forced to leave. Furthermore, the filling up of wetlands and floodplains increases the vulnerability to seasonal floods leaving inland communities more exposed while prolonged periods of drought affects the availability of aquatic resources thus increasing hardship. Likewise, sea grass beds are affected by sea surface temperature rise particularly impinging plant growth and other physiological functions. Distribution pattern of aquatic species would most likely shift due to variations in temperature and sea-depth, and there are already reports on changes in migration pattern.

### **7.2 Impacts of Climate Variability and Climate Change on Capture Fisheries**

Climate variability and climate change are modifying the distribution, migration pattern, and productivity of marine and freshwater aquatic species and already affecting biological processes and altering food webs (FAO, 2009a). The adaptive capacity of the environment is highly affected by changes in water temperature. Changes in habitat temperature greatly affect their growth rate, metabolism, reproduction seasonality and efficacy, susceptibility to diseases and toxins, and their spatial distribution (Lehody, 1997 as cited in Santos *et al.*, 2011). Fish may tend to move to cooler and tolerable waters thus changing their migratory patterns and known availability. Variability in the rain and dry season monsoon pattern has implications on the migration and spawning of fish in inland water bodies and it is generally understood that a “good” flood season is combined with an abundance of fishery resources.

Changes in the distribution through migration (either spawning and/or feeding) of stocks will ultimately affect the availability of aquatic resources at certain place and time. Other profound effect to stocks is the availability of food (as would be the case in inland waters during a prolonged dry season) as a result of climate variability and in the longer term more permanently by climate change. The changes in global climatic patterns and season, will affect fish recruitment and population. The warming of river basins and estuarine waters could affect yields from

fisheries either positively or negatively depending on the resulting dissolved oxygen concentrations and aquatic productivity. It is likely that species distribution will occur according to the adaptability of the species involved.

### **7.3 Impacts of Climate Change on Aquaculture Development**

The range of threats and impacts indicated above are, given the specific location (*e.g.* inland, coastal), also to be considered with regards to aquaculture development – albeit due to its very nature more site, or pond specific. In particular, changes in water temperature could influence the growth rate of stocks and metabolism by prolonging the period of culture and increasing production inputs as well as the selection of species to be cultured. The variability of weather conditions, prolonged hot conditions and drought, intense and stronger storm surges are just but a few factors that would most likely influence options for aquaculture. A rising water temperature and adverse rainfall patterns will affect the physical, chemical, and biological quality of the water such as the dissolved oxygen, salinity, pH, nutrients, and plankton dynamics. As such, greater impact will be experienced for those activities in the open environment like floating net cages in lakes and estuaries as well as in the open sea. In addition, the frequent change in water parameter is likely to create increased turbulence hence higher cost to install or maintain infrastructures to hold the fish.

### **7.4 Adaptation and Mitigation Strategies to Balance the Impacts of Climate Variability and Climate Change**

A reversal of present trends of coastal and inland environmental degradation is an important element in efforts to reduce the effects of natural hazards and to mitigate the effects of climate variability and climate change. In the process of rehabilitating important habitats (such as mangroves and flooded forests) and geographical coastal and inland features (such as sandy beaches, mudflats, dunes, floodplains, and other wetlands), efforts should be done to restore protective features and at the same time to maintain critical areas for aquatic resources and fish species during their life cycle. Plans to integrate fisheries management into habitat management should also strive to include schemes to protect against natural hazards appropriate for the specific geographical situation.

Works to mitigate the effects caused by natural hazards should not only be viewed from the perspective of common seasonal monsoon variability in Southeast Asia but also, and increasingly so, in the perspective of longer term climate change that may threaten further the already vulnerable coastal and inland fishing communities. Through the fragmentation of fishing communities,

traditional knowledge on how to “live with the sea” or “how to live with the floods” and how to manage and maintain coastal habitats is rapidly being lost. Similar processes of marginalization in inland fishing communities, including encroachment into wetlands and floodplains also need to be considered in order to reverse the trend.

SEAFDEC in cooperation with collaborating agencies has been implementing programs related to adaptation and mitigation of the effects of climate change in the Southeast Asian region. In order to assess the individual country’s efforts specifically focusing on the emerging regional policy issues related to climate change, SEAFDEC in close collaboration with the AMSs through the ASEAN Fisheries Consultation Forum (AFCF) has identified actions to be implemented that are aimed at mitigating the impacts of climate change. It is emphasized that development of mitigation strategies should at all time be integrated in every fishery related programs and frameworks. Building upon local knowledge and traditional practices, the use of participatory approaches in vulnerability assessment of climate change impacts on coastal and inland communities form as basis for the formulation of local adaptation strategies.

In efforts to build adaptive capacity and to mitigate climate related impacts, it is important to highlight that existing programs and actions being implemented and are of importance to improve fisheries management and the well-being of people involved in fisheries and fisheries related activities (coastal/inland fisheries, commercial fishing, processing and post-harvest), are also relevant in terms of responses from the sector to climate change and local variations in monsoon and hydrology patterns. Indeed, good habitat and fisheries management will build the resilience and robustness of the aquatic systems, making them less vulnerable to climate change stresses.

Furthermore, there is a need to develop reporting methods and indicators, on how actions taken can contribute to building up of adaptive capacity to mitigate the effects caused by climate change. In addition, awareness programs on the short-term and long-term effects of climate change to the environment should also be taken into consideration, and efforts should be solicited to mitigate such effects. Programs for livelihood diversification to lessen dependence on current income sources among fisherfolk should also be considered. Provision of other means of income among artisanal or subsistence fisherfolk gives them opportunities and lessen their dependence on fishing, thus, also lessens their vulnerability to environmental changes. Risk reduction among fishers working in harsh offshore conditions as well as among small-scale fisherfolk in coastal and inland waters is crucial. Likewise,

governments should exert efforts to strengthen adaptive measures and provide tools for safety at sea to people engaged in fisheries related activities. Ideally, wide range, reliable, accessible, and up to date meteorological services should be in place in the Southeast Asian region.

In aquaculture, research and development initiatives should similarly be geared to respond to the impact of climate change and the need to build mitigation strategies for people engaged in inland and coastal aquaculture as suitable, given the geographical location of the region. Researches should continue to be equipped towards culture stocks and strain development focusing on stocks with wider tolerance to environmental changes including alternative feed sources to lessen dependence on fishmeal. To lessen the impact of climate change on aquaculture activities, countries should develop and implement appropriate action plans that integrate climate change mitigation strategies into aquaculture development plans.

## **7.5 Reducing Carbon Footprints from Fisheries and Aquaculture**

The global consensus and concern that dependence on fossil fuels and non-renewable energy sources should be significantly reduced in the coming decades focus in tapping alternative and renewable energy sources. In addition, global targets for the reduction of the emission of greenhouse gases should be established. Through SEAFDEC and collaborating organizations, the fisheries and aquaculture sectors could continue to strengthen their efforts to reduce carbon footprints and to mitigate environmental impacts which contribute to climate change. It is well recognized that reducing fossil fuel dependence in fishing operations would entail several measures that include the development and promotion of cost effective technologies, backed up by appropriate policy structures for the management of energy use in fisheries in the region. In addition, fuel and energy source alternatives should be identified, while R&D on environment-friendly and efficient capture technologies should be pursued (SEAFDEC/TD, 2011). Projects have already been initiated in the Southeast Asian region concerning measures to reduce the fossil energy dependence in capture fisheries. Involvement of and awareness raising in the private sector should continue to be enhanced with the objective of reducing the use of fossil fuels while relevant programs should be promoted in collaboration with other institutions including the academe, NGOs, and research institutions, in developing advocacies relative to minimizing the contribution of fisheries to climate change. Energy saving programs would have the added benefit in reducing fuel costs for people engaged in fisheries and fish processing.