Mitigating the Impacts of Climate Change: Philippine Fisheries in Focus

Mudjekeewis D. Santos, Jonathan O. Dickson and *Pierre Easter L. Velasco*

Southeast Asia is one of the world's most vulnerable regions to climate change and thus, it is urgent to mitigate the impacts of climate change and build up adaptive capacity of the region in order to ensure long-term food security and sustainability. As a climate change hotspot, the Philippines had been ranked eighth among the countries most vulnerable to some of the worst manifestations of climate change. It is for this reason that the Philippine Government enacted the Philippine Climate Change Act of 2009 (RA 9729) providing for the creation of the Philippine Climate Change Commission which is tasked to formulate and implement plans for the country to better prepare for and respond to natural disasters. Although the impacts of climate change on the structure and the productivity of the marine ecosystems vary with the fishery, it could result in modifications of the distribution of the resources, the consequences of which could be very significant to the development of the region's fisheries.

Southeast Asia is one of the world's most vulnerable regions to climate change because of its long coastlines, specific dependence on seasonal patterns of the monsoon, high concentration of population and economic activity in coastal areas, and heavy reliance on agriculture, fisheries, forestry and other natural resources (IPCC, 2007). To ensure long-term food security and sustainability in the Southeast Asian region, the need to mitigate the possible impacts of climate change and build up adaptive capacity to mitigate its effects on the natural resources, ecosystem, and livelihoods was deemed urgent. Although the impacts of climate change on the structure and the productivity of the marine ecosystems could vary depending on the type of fishery, stressors, and the biological characteristics of the target species, any movements in a particular aquatic environment could be conducive to rapid growth of high-value species in that environment. However, the reverse may not be true in some instances because more often than not, climate change results in modifications of the area of distribution of resources resulting to migrations towards the North or South pole whichever is closer from such environment. Therefore, the consequences of such phenomenon could be very crucial for the sustainability of fisheries.

The United Nations Climate Summit in Copenhagen in 2009 declared the Philippines as the eighth among the top ten countries most vulnerable to climate change and the only country in Southeast Asia included in the top ten countries led by Bangladesh and India. The Philippines as an archipelagic nation of over 90 million faces, is more exposed to more severe typhoons, floods, landslides, droughts, volcanic eruptions, earthquakes, and tsunamis than any other country in Southeast Asia. In the last two decades, the country has experienced the worst of extreme weather conditions. From the early 1990s until 2008, the country suffered the most casualties and experienced the most damages from extreme weather with almost 800 deaths per year and an average of US$ 544 million worth of climate-related damages (Natividad, 2009).

In 2009, tropical storm "Ondoy" and Typhoon "Pepeng" caused massive flooding and landslides, damaging infrastructures and resulting in losses of crops worth close to Philippine Pesos (PHP) 30.0 billion, while more than 600 human lives were lost from Metropolitan Manila to Northern Luzon and an estimated 7 million Filipinos seriously affected. The impacts of the natural hazards since 1900s cost the country more than US$ 7.0 billion in damaged properties losing an estimated 50,000 human lives. Aside from typhoons, the country is also periodically affected by the El Niño Southern Oscillation (ENSO) phenomenon.

Specifically, during the period from 1990 to 2003, a severe El Niño-driven drought was attributed to agriculture losses worth more than US$ 372.0 million. The impacts of climate change therefore constitute additional pressure that could exacerbate the current degradation of the Philippine ecosystem. Moreover, the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) made projections of some attributes to climate change in the Philippines for 2020 and 2050 (The Philippine

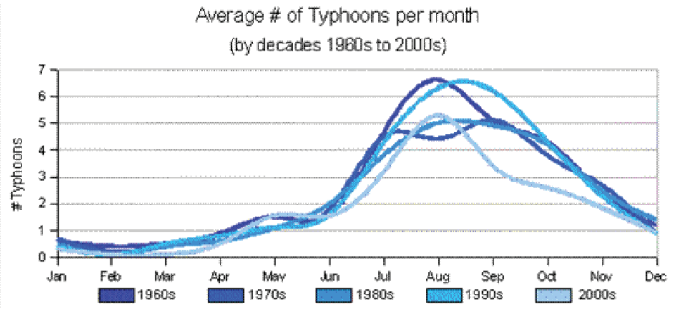


Fig. 1 Average monthly occurrence of typhoons in the Philippines

Strategy for Climate Change and Adaptation, DENR, unpublished), indicating that there would be a projected rise in mean annual temperature of 0.9-1.4°C, while the dry season from March to May will intensify and the wet season from July to November would be wetter. Most part of Mindanao will experience less or reduction of rainfall for all seasons but an increasing number of much stronger tropical typhoons will hit the Visayas area. The mountainous regions or areas with high elevation in slope mostly in northern Luzon, Mindanao, Mindoro, Negros and Panay will be more vulnerable to excessive rains, landslides, and flashfloods. **Fig. 1** shows the average monthly occurrence of typhoons in the Philippines from 1960s to 2000s.

According to Dr. Herminia A. Francisco of the Singapore-based Economy and Environment Program for Southeast Asia (EEPSEA), 10 provinces in Luzon and the country's capital Metropolitan Manila are the most vulnerable to the impacts of climate change (Yusuf and Francisco, 2009). This claim was also supported by the research conducted by the Asian Development Bank (ADB) and the World Wild Fund for Nature (WWF) some years back, that a 90 cm seawater upsurge due to sea level rise will inundate some of the reclaimed areas in Metro Manila.

Effects of Climate Change to Philippine Fisheries

As an archipelagic state, the total territorial waters or EEZ of the Philippines is about 2,200,000 km^2 (coastal: 266,000 km^2 and oceanic: 1,934,000 km^2) and the length of its coastline is 17,460 km. With vast coastal and inland waters, the country ranks the 8th among the world's top-producing countries of fish as well as other aquatic and marine products. The Philippines also sits at the apex of the Coral Triangle, which supports an array of biodiversity and recognized as the global epicenter of marine biodiversity. The Coral Triangle encompasses at least 500 species of reef-building corals in each sub-region and the highest diversity of coral reef fishes in the world.

Seventy percent of the protein requirements of the Filipinos for nutrients, minerals, and essential fatty acids are derived from fish, and over 1.6 million Filipinos depend on the fishing industry for their livelihood. The contribution of the Philippine fishing industry to the country's Gross Domestic Products (GDP) was 2.3% and 4.3% at current and constant prices, respectively. The country's 2008 fisheries production of 4.965 million mt (**Table 1**) indicated a remarkable 5% increase from the 2007 production of 4.711 million mt. In terms of value, the country's 2008 fish production valued at US$ 4.7 billion was about 20% higher than the US$ 3.9 billion production value of 2007 (SEAFDEC, 2010).

The Philippines' total production of 4.965 million mt of fish, crustaceans, mollusks and aquatic plants including seaweeds in 2008 contributed 3.5% of the world's total catch of 142.3 million mt (FAO, 2010), and made the country the 8th largest producer of fish in the world. Specifically in 1999, the Philippines became the 3rd biggest producer of seaweeds and other aquatic plants accounting for 10% (1,505,070 million mt) of the world's production of 14.85 million mt. Moreover, in 2008 the country's fishery exports amounted to US$ 768.0 million from production of 205,274 mt compared to imports of only US$ 195.0 million. The major fisheries export commodities include tuna, shrimps/prawns and seaweeds, while the major imports were chilled/frozen fish and fish meal (Philippine Fisheries Profile, 2008).

Despite the vastness of the country's fishery resources, it is unfortunate that the Philippines is also considered the world's top biodiversity hotspot, mainly because of its depleted fishery resources; degraded coastal environment and critical fisheries habitats due to siltation from deforestation, destructive fishing practices, overharvesting of mangroves, lime and sand quarrying, among others; low incomes and dissipated resource rents; reduced value of

Coral Triangle with Philippines at the apex

Table 1. Fisheries production of the Philippines: 2004-2008 (Qty in '000 mt; Value in '000 000 US$)

Fisheries Sub-sectors	2004		2005		2006		2007		2008	
	Qty	Val	Qty	Val	Qty	Val	Qty	Val	Qty	Val
Marine capture	2,067.1	1,597.4	2,122.2	1,680.7	2,154.8	1,997.6	2,327.8	2,452.0	2,377.5	2,810.9
Inland capture	142.0	80.4	143.8	84.1	165.1	101.5	168.4	125.5	179.5	145.9
Aquaculture	1,717.0	799.8	1,895.9	892.5	2,092.3	1,085.0	2,214.8	1,334.7	2,407.7	1,718.6
TOTAL	**3,926.1**	**2,477.6**	**4,161.9**	**2,657.3**	**4,412.2**	**3,184.1**	**4,711.0**	**3,912.2**	**4,964.7**	**4,675.4**

Source: *Fishery Statistical Bulletin of Southeast Asia 2008 (SEAFDEC, 2010)*

catches due to poor post-harvest practices; inter-sectoral as well as intra-sectoral conflicts and poverty; and poor system of fisheries management (Luna *et al.*, 2004). Thus, the fishing communities and people dependent on fisheries and aquaculture as producers and consumers in inland or coastal areas would be vulnerable to the impacts of climate change in terms of dwindling stable livelihood, decreasing availability or quality of fish for food, and increasing safety risks from fishing operations during harsh weather conditions (FAO, 2008).

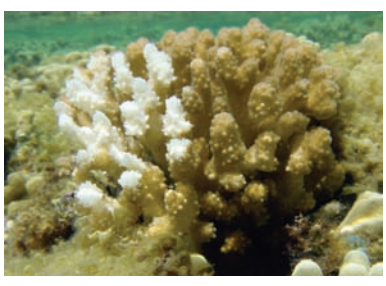
Increasing sea surface temperature and El Niño southern oscillation

Aquatic animals such as fishes are poikilothermic, which means that their body temperatures vary with the ambient temperature. Any changes in habitat temperature (climate change induced) greatly affects the growth rate, metabolism, reproduction seasonality and efficacy, susceptibility to diseases and toxins, and spatial distribution of fishes (Lehody *et al.*, 1997). This in turn, affects fishing operations or the "hunt for fish" due to loss of traditional fishing grounds. This phenomenon has been observed on the migration of tunas particularly the skipjack which moves to the cooler central Pacific Ocean reducing tuna stock supply for the people in the Coral Triangle region including the Philippines (Alcala, 2010).

Increasing sea surface temperature (SST) has also been attributed to the recurrence of harmful algal blooms (HAB) specially the dominant alga *Pyrodinium bahamense* var *compressum*, whose growth development pattern is easily affected by major climate changes (Capili *et al.*, 2005). Too much warming also affects the growth rate and physiological function, distribution, and patterns of sea grass reproduction. Lakes, rivers and inland bodies of water are also greatly affected. As the sea surface temperature increases and precipitation lessens, water level may drop resulting in stronger and longer stratification of lakes and reservoirs, and with limited seasonal turnover deoxygenation of bottom layers occurs that results to massive fish kills, *e.g.* fish kill in Magat Dam in 2010.

Due to the effect of the El Niño phenomenon in 1998, the Philippines experienced the hottest and driest season ever recorded. It is expected that the El Niño Southern Oscillation or ENSO will increase its frequency and intensity in the coming decade. Increased temperature is one stressor that causes the corals to bleach, diminishing their growth and threatening the critical habitats for fish and other marine organisms. In fact, the 1998 El Niño caused massive coral bleaching around the world, and as reported in the National Geographic, over 16% of the world's coral reefs were lost in that one year which also affected 49% of the Philippine coral reefs. According to Reef Check, fish species were already starting to disappear as coral reefs were destroyed around the Philippine archipelago, while

Magat Dam is a large rock-fill dam in Magat River, a major tributary of Cagayan River in the Philippines. Massive fish kills occurred in the Dam in early 2010 due to lack of oxygen in its waters.



Incidence of coral bleaching in Philippine coral reefs

O'Meara of the Washington-based Worldwatch Institute said that "a 1-2°C increase in temperature can cause corals to bleach and sustained increase of 3-4°C causes corals to wither and die as they expel the algae (zooxanthellae) that provides them with food and lend them their vibrant colors". The total economic value from coral reef fisheries of the Philippines is estimated at US$ 1.1 billion annually and ranks second in the region following Indonesia with 1.6 US$ billion annually. The El Niño phenomenon in 1998 resulted in decreased live coral cover nationwide by about 49% due to coral bleaching associated with the warming of sea water surface. This had severely damaged the network of corals in the world's largest contagious coral reef system, the 27,469 ha Apo Reef in Occidental Mindoro, Philippines.

Sea level rise

Sea level rise (SLR) has been considered as a significant effect of global warming, where the sea level increases due to the thermal expansion of the water and through the addition of water to the oceans from the melting mountain glaciers, ice caps and ice sheets. According to Greenpeace, a one-meter rise in sea level is projected to affect the country's 64 out of 81 provinces, covering at least 703 out of 1,610 municipalities and inundating almost 700 million square meters of land, threatening low-lying communities and endangering the quality of drinking water and agricultural productivity due to salt intrusion. The IPCC (2009) also added that a centimeter rise in sea level erodes at least a meter of beach horizontally, damaging or destroying many coastal ecosystems such as mangroves and salt marshes, essential to maintaining wild fish stocks as well as supplying seeds for aquaculture. Mangroves and other coastal vegetation buffer the shore from storm surges that can damage fish ponds and other coastal infrastructures, which could become more frequent and intense due to climate change. UNEP estimated that the annual ecosystem value of mangroves in the country is US$ 200,000-US$ 900,000/km^2. Other climate change-related threatened critical ecosystems of the Philippines include the nesting sites of sea turtles and sea birds as well as the premier beaches in the country. Increasing sediment loading due to SLR affects the submerged aquatic sessile organisms, disrupting ecosystem balance and increasing the potential for disease among oysters. As a result, aquatic flora and fauna will be more susceptible to the stresses affecting their reproductive processes as they endure the prolonged environmental warming.

Sea level rise would also affect tidal variations, alter water movements and reduce light intensity vital to the productivity of sea grasses and corals (Short, 1999). The possible effect on marine protected areas, *refugia*, and marine reserves could be its inability to continue preserving the habitats of aquatic flora and fauna as climatic zones shift. The physical effects of SLR may cause substantial socio-economic losses of coastal structures both natural and man-made, dislocation of the population and loss of livelihoods (Perez *et al.*, 1999).

Ocean acidification

Warming of the ocean decreases its capacity to dissolve CO_2 (Capili *et al.*, 2005) and the rise of CO_2 in ocean waters leads to more corrosive conditions for calcifying organisms, making it more difficult for rebuilding and maintaining their carbonate skeletons. Moreover, too much CO_2 concentration will also enhance the primary production of carbon limited sea grass areas disrupting the balance between sea grass and algal populations.

Ocean currents and circulation

The deepening of the thermocline layer and stronger thermal stratification brought about by climate change will affect and ultimately change the dynamics of plankton productivity and disrupting upwelling zones by preventing cool nutrient rich waters from being upwelled in some areas (Roemmich and McGowan, 1995). This can enhance plankton productivity and result in faster water evaporation allowing the colder, nutrient-rich waters to surface. Thus,

Box 1. Status of major fish resources and habitats in the Philippines

Resource/Habitat	Status	Source
Corals	Degraded state	BFAR-NFRDI-PAWB. 2005. BINU
Seaweeds	Unknown (except declining seed source)	BFAR-NFRDI-PAWB. 2005. BINU, GTZ (2009)
Sea grass beds	Heavily stressed	BFAR-NFRDI-PAWB. 2005. BINU
Mangroves	Degraded state	BFAR-NFRDI-PAWB. 2005. BINU
Invertebrates	Declining trend	BFAR-NFRDI-PAWB. 2005. BINU
Demersal fishes	Declining trend	BFAR-NFRDI-PAWB. 2005. BINU
Small pelagic fishes	Declining trend	BFAR-NFRDI-PAWB. 2005. BINU
Tunas	Stable trend (except big eye tuna)	BFAR-NFRDI-PAWB. 2005. BINU, WCPFC (2009)
Sharks and rays	Declining trend	NPOA Sharks (2009)
Marine turtles	Threatened	BFAR-NFRDI-PAWB. 2005. BINU
Marine mammals	Threatened	IUCN Red List (2009)

toxic algal blooms become very eminent, and as a matter of fact, the recurrence of toxic algal blooms in Manila Bay has been attributed to the increased SST (Capili *et al.*, 2005).

Climate change is also modifying the distribution of both marine and freshwater species. Warmer-water species are being pushed towards the poles, and experience changes in habitat size and productivity affecting the seasonality of biological processes (**Box 1**), altering the marine and freshwater food webs with unpredictable consequences for fish production.

Increased occurrence of stronger typhoons, storms, and drought

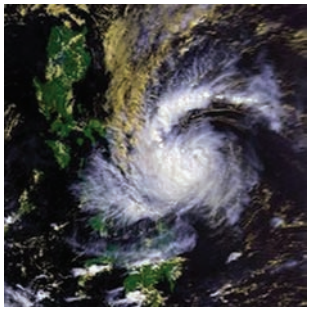
Increased incidence of extreme events such as floods, droughts and storms will affect the safety and efficiency of fishing operations, and increase damages and disruptions to coastal and riparian homes, services and infrastructures (**Box 2**). Extreme events such as cyclones and associated storm surges as well as inland flooding can have serious impacts on fisheries, damaging or losing some stocks, facilities and infrastructures and increasing the risks and safety of lives at sea. According to Dr. Leoncio A. Amadore, a Meteorologist of PAGASA, the extreme tropical cyclones/ southwest monsoon-induced events from the 1990s until 2000s were influenced by global warming. For example, Typhoon *Reming* which hit the Philippines in 2006 had triggered the Legazpi Mudslide and the Guinsaugon, Leyte Landslide, the 2nd and 3rd World's Deadliest Disasters of 2006, respectively, where more than 2,500 people were killed and almost 800,000 families were affected by such calamities (Center for Research on the Epidemiology of Disasters).

Specifically, tropical cyclones had intensified from 1975 to 2002 causing annual average damages to property of PHP 4.5 billion (around US$ 90.0 million) including damages to agriculture amounting to PHP 3.0 billion (around US$ 60.0 million). In 2006, the typhoons that passed the country affected at least 11 million Filipinos and inflicted damages to agriculture and infrastructures amounting to almost PHP 20.0 billion (Greenpeace, 2007). This does not include the PHP 500.0 million worth of assistance and donations in 2006 and PHP 10.0 billion allocated by the Philippine Government in its 2007 national budget to rehabilitate direct-hit areas.

Thus, in order to address these pervasive and longer-term impacts, climate change adaptation (CCA) should be mainstreamed into key development processes.

Box 2. Abiotic changes associated with climate change and effects on fishery resources and habitats

Abiotic changes due to climate change	Effects on fishery resources, habitats, and people
• **Sea surface temperatures (SST)** **Observed**: ~ 0.11°C/decade (1950-2007) **Projected**: ~ 1.00-3.00°C by end of century	• Coral bleaching, branching corals vulnerable • Fishes move to cooler areas, since tolerance limits narrow, risks of extinction increased: tuna, skipjack moving to cooler central Pacific Ocean, reducing fish supplies for people elsewhere in Coral Triangle region including the Philippines
• **Ocean acidification** **Observed**: ~ 0.1 units **Projected**: ~ 0.3-0.4 units by 2010 Aragonite saturation state and coral calcifications marginal in 2020-2050	• With doubling atmospheric carbon dioxide, reduction of calcification in corals and species with carbonate skeletons, corals become more fragile, recovery becomes slower; both increasing SSTs and acidification increase stress to corals through increased disease virulence, making corals susceptible to breakage
• **Sea level rise** **Observed**: ~ 10-20 cm over 20th century (especially true for Philippines) **Projected**: a further rise of 30-60 cm by 2010, with ice melting 4-6 m by 2100	• Flooding of low islands and low lying areas resulting in land erosion, sea water intrusion in coastal land areas, population displacement, landward growth movement of mangroves, changes in phenology of mangroves
• **Tropical cyclones** **Observed:** Doubling in frequency of super typhoons **Projected**: Become more intense with heavier rainfall	• Increasing frequency and strength weaken skeletal framework of corals, accelerate erosion of beaches, weaken coral resistance to disease, prevent normal recruitment of marine species including fish species used as food
• **El Niño Southern Oscillations** **Observed**: Has occurred in recent past **Projected:** Will be significant source of climate variability	• Worsen the effects of other climate change stresses
• **Storm surges, strong monsoon winds** **Observed:** Increasing frequency and severity **Projected**: Will increase in severity	• Coastal erosion in small islands, destruction of infrastructures and buildings
• **Ocean circulation** **Observed:** Little information at present **Projected:** Some upwelling could cease and horizontal currents could change directions, altering oceanographic regimes, resulting in changes in ocean productivity	• Prevents normal dispersal and distribution of larvae of marine species, mangrove and coral propagules, resulting in low fish and fishery productivity, degradation of coral reef systems, decline of coastal and reef fishes, and failure of fish recruitment



Strong typhoon approaching the Philippine area of responsibility in November 1991

Nevertheless, there are barriers to mainstreaming CCA, which could include: (a) general lack of awareness and understanding of climate change and adaptation specifically both the public and top-level decision makers; (b) institutional weaknesses and unclear mandates of various agencies and coordinating bodies; (c) inadequate budget allocations and lack of secure financing to effectively and sustainably promote the integration of CCA in policies; and (d) inadequate linkage between longer-term adaptation efforts and immediate responses to extreme weather events and natural disasters, which could address both more effectively. "*What occurred this year and the previous year can only be expected to be repeated or to become worse in the future. Our people must therefore prepare for the worst scenario. The key to this preparation is the Local Government Unit...*" (Alcala, 2010).

Mitigation, Adaptation and Responses to Changing Environmental Conditions.

"*The Philippines vulnerability or the extent to which its people and systems are affected as a developing country is determined by three factors: their exposure to specific change; their sensitivity to that change; and their ability to respond to impacts or take advantage of opportunities. Understanding these patterns of vulnerability enables the identification of specific adaptation interventions ...*" FAO.

In 1995, the Philippines hosted the First Asia-Pacific Leaders' Conference on Climate Change where representatives from 133 countries signed the Manila Declaration. Among others, the Manila Declaration acknowledged the dangers posed by climate change phenomenon to archipelagic nations such as the Philippines. "*Small island states, coastal, and other nations of the Asia Pacific region, including the many centers of economic, biological, and cultural viability and diversity, are extremely susceptible to climate change and sea level rise*," was emphasized in the Declaration.

Republic Act (RA) 9729: The Philippine Climate Change Act of 2009

In order to harmonize the country's programs involving climate change adaptation and mitigation, RA 9729 or the Philippine Climate Change Act of 2009 was enacted into law recognizing the urgent need for a "Framework Strategy" and "National Climate Change Action Plan". The law also provides for the creation of a Climate Change Commission as "the sole policy-making body of the government and tasked to coordinate, monitor and evaluate the programs and action plans of the government relating to climate change," with the Philippine President as Chairman of the Commission. The Climate Change Act provides that both the Framework and the Plan should be completed within a period of two years. The CCC has thus far completed its National Framework Strategy, while the Action Plan was due for completion by April 2011. Moreover, Sec. 14 or the Local Climate Change Action Plan of RA 9729 recognizes the important role of the LGU (municipal and barangay levels) in the formulation, planning and implementation of climate change action plans in their respective areas, consistent with the provisions of the Local Government Code, the Framework, and the National Climate Change Action Plan.

The Philippine Climate Change Commission

Established by Republic Act 9729 or the Philippine Climate Change Act, the Philippine Climate Change Commission is an independent and autonomous body that has the same status as a national policy and is attached to the Office of the President. Among its tasks are the formulation and implementation of plans for the country to better prepare for and respond to natural disasters. The Commission also promotes close coordination with local government units (LGUs) and private entities to address vulnerability to the impacts of climate change in the regions, provinces, cities and municipalities; capacity building for local adaptation planning, implementation and monitoring of climate change initiatives in vulnerable communities and areas; and provision of technical and financial support to local research and development programs and projects in vulnerable communities and areas.

National Framework Strategy on Climate Change 2010-2022

Within the context of the country's sustainable development goals and governance factors that affects the country's ability to respond to climate change, its National Framework Strategy on Climate Change was formulated to cover the period from 2010 until 2022. The Framework is specifically geared towards ensuring and strengthening the adaptation of the natural ecosystems and human communities to climate change. It also seeks to chart a cleaner development path for the Philippines highlighting mutually beneficial relationships between climate change

adaptation and mitigation. The Framework highlights the critical aspects of adaptation intended to be translated to all levels of governance alongside the coordinating national efforts toward integrated ecosystem-based management which shall render all sectors climate-resilient.

The Philippine government has submitted its National Framework Strategy on Climate Change (NFSCC) to the United Nations (UN) in order to be able to access the US$ 250-350 million Adaptation Fund (AF) established under the Kyoto Protocol. The proposal was also envisaged to enable the Philippines and its people cope with the impacts of the changing climate. The Climate Change Commission (CCC) Vice Chairman, Mr. Heherson Alvarez reported that the Framework highlighted the vulnerability of the Philippine archipelago to heavy rains, floods, landslides, droughts and sea level rise, in a bid to access the Fund by 2012.

The Philippine Climate Change Adaptation (CCA) Project

The objective of the Climate Change Adaptation (CCA) Project of the Philippines is to develop and demonstrate approaches that would enable the target communities to adapt to the potential impacts of climate variability and change. The project has four components as shown in **Box 3**.

The Philippine Water Sector Adaptation Strategy on Climate Change

The Water Sector Adaptation Strategy on Climate Change was developed to reduce the vulnerability of the water sector and increase the resilience of communities and ecosystems to climate change utilizing a broad based participatory process of key stakeholders of the sector. The four strategic outcomes to be achieved by 2050 were identified supported by 12 strategic objectives and several key actions for 2010 until 2022 (**Box 4**).

Box 3. Components of the Climate Change Adaptation Project of the Philippines

i) Strengthening the enabling environment for climate change adaptation, by supporting the integration of climate change adaptation into the agriculture and natural resources sectors, and strengthens the capabilities of relevant government agencies;
ii) Demonstration of climate change adaptation strategies in the agriculture and natural resources sectors, by helping poor rural communities, which are most at risk of climate change impacts, to adapt to the effects of climate change. It will demonstrate both tangible reductions in climate-related risks, and increased resilience to longer-term climate changes and climate-related disasters;
iii) Enhanced provision of scientific information for climate risk management. This component improves the access of end users, especially in the agriculture and natural resources sectors, to more reliable scientific information that would enable more rapid and accurate decision making for climate risk management; and
iv) Project coordination.

Box 4. Expected outcomes of the Philippine Water Sector Adaptation Strategy on Climate Change by 2050

i) Effective, climate change responsive, and participative water governance;
ii) Reduced water sector vulnerability and resilient communities and natural ecosystems;
iii) Improved knowledge on water sector adaptation and climate change; and
iv) Sustainable and reliable financing and investment for climate change adaptation in the water sector.

Adaptive water governance includes the mainstreaming of adaptation in national and local policies and development plans. It also entails reforming the policies to address institutional fragmentation in water resources management in the country and to climate-proof existing laws. Building resilient communities and ecosystems, improve their adaptive capacities, and reduce vulnerability would entail taking serious assessment of the existing water infrastructures to determine their vulnerability to extreme events; implementing modifications in the processes and demands of existing systems and water users; adopting low cost, "no regret" adaptation technology options; and enhancing the capability of communities and existing institutions for integrated water resources management.

BFAR and NFRDI Climate Change Adaption Programs

The Bureau of Fisheries and Aquatic Resources (BFAR) as the lead agency in safeguarding, protecting and conserving the vulnerable fishery resources as well as the people, community and institutions associated with the fishery sector, has identified key mitigation and adaptation programs, and National Action Plan in response to the impacts of the changing environment (**Box 5**). On the other hand, the National Fisheries Research and Development Institute (NFRDI) also identified and included in the 2011 pipeline, climate change-related research and development projects (**Box 6**).

Regional Fisheries Policy Recommendations on Mitigation and Adaptation of the Impacts from Climate Change

Due to the drastic changes of global environment and the declining of fishery resources, the challenges on "climate change" and its impacts to fisheries had been the serious topics progressively discussed at the international and regional arena. In tropical waters, the impacts of climate change are generally seen from the "sea level rise and increasing sea-surface temperature, the most probable major climate change-related stresses on the coastal ecosystems". This situation could affect the development of fisheries making it more difficult to improve the people's livelihoods and ensure food security as well as address fisheries management approaches.

Box 5. Key adaptation programs and the National Action Plan of BFAR in response to the impacts of changing environment

i) Vulnerability assessment and establishment of rapid alert systems (BFAR SOP on Disaster mitigation and preparedness)
ii) Diversify livelihoods:
- Mariculture Parks (Fish cages for livelihood)
- Expansion of aquaculture production areas targeting abandoned or unproductive fishfarms (FLAs)
- Allocate seed money that will help fisherfolks become fishpond operators
- Provision of guarantee fund

iii) Formulation and implementation of High Value Fish Species Development Plan
iv) Active participation in the activities of the Coral Triangle Initiative
v) Conduct of more research and development

Box 6. R&D projects of NFRDI on climate change

i) Vulnerability assessment of Philippine Fisheries and aquaculture to climate change
ii) Geospatial information technologies and application for fisheries management modernization (GITAFIMM)
iii) Socio-economic survey of women and children in Philippine fisheries
iv) National Stock Assessment Program (NSAP)

Establishment of coral garden and marine protected area in Aklan, central Philippines

Through a series of regional consultations, the issue on the effect climate change to fisheries has been raised, and the required follow-up actions for SEAFDEC and Member Countries to undertake in response to the issues had been identified (**Box 7**).

Recommendations for Future Activities

Many artisanal fishers are extremely poor. Even in cases where they earn more than other rural people, fishers are often socially and politically marginalized and can afford only limited access to healthcare, education and other public services. Social and political marginalization leaves many small-scale and migrant fishers with little capacity to adapt, and makes them highly vulnerable to climate impacts affecting the natural capital resource that they heavily depend on for their livelihoods. Heightened migration to cope with and exploit climate-driven fluctuations in production could also worsen a range of cultural, social and health problems. Focusing on the recommendations of emerging regional fisheries policy issues relevant to climate changes during a series of regional consultations, SEAFDEC in collaboration with the Member Countries especially with the Philippines as the Lead Country for the AFCF key cluster on Climate Change, would consolidate all efforts to implement the activities that are aimed at mitigating the impacts of climate change as shown in **Box 7**.

References

Alcala, Angel. 2010. Climate change revisited. Malaya Insight. Philippines; 8 October 2010

BFAR. 2008. Philippine Fisheries Profile. Bureau of Fisheries and Aquatic Resources, Philippines

Box 7. Proposed activities to mitigate the impacts of climate change to be undertaken by SEAFDEC and the national agencies responsible for fisheries in the Member Countries

Strengthen capacity of fisheries sector in tackling with climate change

- Clear organizational long-term policy on human resources development and capacity building in response to the emerging needs relevant to climate change (SEAFDEC and national agencies responsible for fisheries)
- Promote awareness program on climate change and its impact to fisheries and aquaculture to all stakeholders (Member Countries)
- Build up the resilience of fisheries communities in response to the impact of climate change
- Establish simple meteorological information system and network for fisheries communities
- Mainstream policy on poverty alleviation and remedial actions for the people affected by the climate change

Integrate climate change into fisheries policy framework

- Review existing regional policy framework and priority actions to accommodate the issues on climate change and its impacts to fisheries/aquaculture (SEAFDEC)
- Conduct national seminar/workshop involving other relevant agencies and stakeholders to develop national fisheries policy and action plans on climate change and fisheries/aquaculture (Member Countries)
- Increase dialogue and discussion with other sectors on issues relevant to climate change (Member Countries) that due consideration be given to the contribution from fisheries and aquaculture as the main food production sector, when developing respective national policy action plans to minimize their impacts to climate change (Member Countries)
- Use the climate change as an opportunity for fisheries related agencies to pro-actively approach higher level authorities in assisting the affected sectors to get supportive measures from the government, *e.g.* appropriate subsidies, pricing policy, poverty alleviation program, etc. (Member Countries)

Integrate climate change into existing fisheries program frameworks

- Identify (Member Countries) and monitor vulnerable fishing communities that will be submerged by sea-level rise or affected by erosion, destruction of natural habitats, storms as well as those affected by fisheries and aquaculture activities (SEAFDEC and Member Countries)
- Identify and develop appropriate indicators for monitoring and assessing the impacts of climate change to fisheries resources and aquaculture, *e.g.*: water cycle, change in season and temperature, seawater intrusion, fisheries resources, indicator species (SEAFDEC and Member Countries)

Marine Fisheries

- Integrate climate change into existing marine fisheries program frameworks
- Identify (Member Countries) and monitor vulnerable fishing communities that will be submerged by sea level rise or affected by erosion, destruction of natural habitats, storms as well as those affected by fisheries and aquaculture activities (SEAFDEC and Member Countries)
- Identify and develop appropriate indicators for monitoring and assessing the impacts of climate change to fisheries resources and aquaculture, *e.g.*: water cycle, change in season and temperature, seawater intrusion, fisheries resources, indicator species (SEAFDEC and Member Countries)

Inland Fisheries

- Collaborate with relevant agencies (*e.g.* WorldFish Center and MRC) in conducting research activities and develop a model on the impact of climate change to flooding (SEAFDEC/Member Countries)
- Undertake program on management of inland fisheries during the dry season (establishment of refuge) in order to alleviate the impact of climate change on the rural people's livelihood (Member Countries)
- Undertake program on wetland management in the broader context (Member Countries)

Aquaculture

- Investigate the possible impacts of climate change to aquaculture, *e.g.* stratification and eutrophication, freshwater shortage in dry season, flooding in rainy seasons, sea water intrusion, increasing feed requirement for aquaculture, change in availability of seedstocks, disease susceptibility, etc. (SEAFDEC and Member Countries)
- Adapt aquaculture technologies and practices in response to the impact of climate change (SEAFDEC and Member Countries), *e.g.*:
  - Recycling of nutrient water in shrimp ponds
  - Selective breeding of species to develop seedstocks with wider tolerance to environmental changes
  - Development of eco-friendly feeds
  - Development of alternate feed materials (*e.g.* earth worms)
  - Promotion of the culture of lower trophic level species with appropriate HRD programs

Minimizing impacts from fisheries/aquaculture to climate change

- Undertake energy saving measures, and promote the use of alternative sources of energy (SEAFDEC and Member Countries)
- Fully utilize low-economic value fish species (*e.g.* jellyfish) with value-added processes, for human consumption (Member Countries)

Information Collection and inter-agency coordination

- Compile information from local communities and stakeholders, *e.g.* through community networking (Member Countries)
- Encourage inter-agency coordination and sharing/mobilization of expertise (SEAFDEC and Member Countries)
- Facilitate sharing of information specifically on adaptive measures relevant to climate change and fisheries/aquaculture (SEAFDEC)

At the end of the consultation, it was recommended that the outcomes from this Consultation would be submitted to the higher authorities of ASEAN and SEAFDEC for consideration and policy support.

Installation of mariculture parks in the Philippines, where 50 parks/zones have been established as of April 2010 and another 9 were scheduled for launching

Capili E.B., A.C.S. Ibay and J.R.T Villarin, 2005. Climate Change Impacts and Adaptation on Philippine Coasts. In: Proceedings of the International Oceans 2005 Conference. 19-23 September 2005, Washington D.C., USA.

FAO. 2008. Climate Change and Food Security in Pacific Island Countries. FAO, Rome, Italy. *http://www.fao.org/climate change/media/17003/0/0/*

FAO. 2010. FAO Yearbook on Fishery and Aquaculture 2008. FAO, Rome, Italy, 2010; 72 pp

Fish Site. 2011. Effects of Climate Change on Fisheries *http://www.thefishsite.com/fishnews/9262/fao-study-effects-of-climate-change-on-fisheries*

Greenpeace. 2001. The Philippines: A Climate Hotspot. Climate Change Impacts and the Philippines, April, 2007

IPCC. 2007. Intergovernmental Panel on Climate Change. Climate Change 2007: Synthesis Report. World Meteorological Organization. Geneva, Switzerland. 104 pp

Lehody, P., Bertignac, M., Hampton, J., Lewis, A., and Picaut, J. 1997. El Niño Southern Oscillation and Tuna in the Western Pacific. Nature 389:715-717

Luna, C. Z., Cesar, G.T. Silvestre, M.F. Carreon III, A.T. White and S.J. Green. 2004. Sustaining Philippine Marine Fisheries Beyond "Turbulent Seas": A Synopsis of Key Management Issues and Opportunities. In: DA-BFAR Turbulent Seas: The Status of Philippine Fisheries. p 345-358

Manila Standard Today. 2011. Arrested development: Climate change readiness in the Philippines *http://www.manilastandardtoday.com/insideOpinion.htm?f=2011/march/4/feature1.isx&d=2011/march/4*

Media Wiley. 2011. Earth and the Greenhouse Effects *http://media.wiley.com/product_data/excerpt/83/04708501/0470850183.pdf*

National Geographic. 2006. Global warming has devastating effects on coral reefs, study shows. *http://news.nationalgeographic.com/news/2006/05/warming-coral.html*

Natividad, Beverly. 2009. Philippines, eighth most vulnerable to climate change. Climate Change Media Partnership 2010

NWBD. 2010. Water Sector Climate Change Adaptation Strategy. National Water Resources Board, Department of Environment and Natural Resources, Philippines

Perez, R.T., L.A. Amadore and R.B. Feir. 1999. Climate change impacts and responses in the Philippine coastal sector. Climate Research. Vol. 12:97-107

Santos, M. D. and S. A. Malvas. ASEAN Climate Change Initiative for Fisheries: Philippine Experience. Paper presented during the ASEAN-SEAFDEC Regional Technical Consultation on Adaptation to a Changing Environment, 1-4 November 2010, Bangkok, Thailand

SEAFDEC. 2010. Fishery Statistical Bulletin 2008. Southeast Asian Fisheries Development Center, Bangkok, Thailand. December 2010; 135 pp

Short, F.T. and H.A. Neckles. 1999. The effects of global climate change on sea grasses. Aquatic Botany, Vol. 63:169-196. 1999

Silent Gardens. 2011. Climate of the Philippines *http://www.silent-gardens.com/climate.php*

Tacio, Henrylito. 2010. Philippines: A Hotspot for Climate Change. People and Planet. *www.peopleandplane.net*

UNEP/GRID-Arendal Maps and Graphics Library. 2002. Causes of sea level rise from climate change. UNEP/GRID-Arendal. Accessed 17 Mar 2011 <*http://maps.grida.no/go/graphic/causes-of-sea-level-rise-from-climate-change*>.

WorldFish Center. 2007. The threat to fisheries and aquaculture from climate change. WorldFish Center Policy Brief. 2007 Variability and climate change *http://www.fao.org/fishery/topic/13789/en*

Yusuf, A. Anshory and Herminia Francisco. 2009. Climate change vulnerability mapping for Southeast Asia. IDRC. EEPSEA publication. *http://.eepsea.org*

About the Authors

Dr. Mudjekeewis D. Santos is the Officer-in-Charge of the Marine Fisheries Division of the National Fisheries Research and Development Institute of the Philippines.

Dr. Jonathan O. Dickson is the Chief of Capture Fisheries Division of the Philippine Bureau of Fisheries and Aquatic Resources, and is the SEAFDEC National Coordinator for the Philippines.

Mr. Pierre Easter L. Velasco is Fishery Officer of the National Marine Fisheries Development Center of the Philippine Bureau of Fisheries and Aquatic Resources, and is the Member for the Philippines of the Regional Fisheries Policy Network based at the SEAFDEC Secretariat in Bangkok, Thailand.