RESILIENCY AND VULNERABILITY OF THE COASTAL ZONE AGAINST SEA LEVEL RISE

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1. Rationale

The Philippines is an archipelagic state with more than 7,000 islands, with a total coastline of around 37,008 km (SCTR Report 2012). The Philippines' warm tropical coastal waters are highly productive, more so that there are around 2,227,400 ha of coral reefs, more than 200,000 ha of mangrove areas, and almost 100,000 ha of seagrass beds (SCTR Report 2012). These nearshore habitats harbor thousands of marine species, resulting in its recognition as the global center of marine biodiversity (Roberts et al. 2002) particularly for its nearshore fishes (e.g. Carpenter & Springer 2005). Altogether, these provide vital ecosystem goods and services that are highly beneficial to human society (De Groot et al. 2002). One of the most salient ecological goods that can be derived from these ecosystems is fisheries for food, as well as livelihood to many fishers–especially in the small artisanal scale (e.g. Worm et al. 2009). There is high value in fisheries, especially for small pelagic catches (e.g. SCTR Report 2012). Moreover, ecosystems (e.g. coral reefs and mangroves) also provide indirect benefits such as coastal protection to climate stressors (e.g. wave surge) to reduce impact of disasters (see Villanoy et al. 2013). Therefore, under a changing climate, it is imperative to determine the vulnerability of the coastal ecosystems (e.g. Licuanan et al. 2015).

2. Marine Biodiversity and Ecosystem function

There are around 2,351 species of demersal fishes recorded so far in the coastal waters of the country; many of these are commercially important (SCTR Report 2012). Corals total to 533 species, mangroves to 42 species, and seagrasses to 16 species. These are distributed in their local geographic ranges; but are quite more abundant in the central and western parts of the country (i.e. Visayas Region, West Philippine Sea, Sulu Sea, and Celebes Sea) compared to the eastern side (i.e. northern Philippine Sea and southern Philippine Sea). Marine species have vital roles in an ecological domain. These species persist in their geographic ranges, whether local or regional, because of their evolutionary and ecological traits (e.g. Anderson 1981; Veron 1995).

In the past decade, advances in ecological and genetic studies revealed connectivity among marine populations and habitats (e.g. Palumbi 2003). There has been an increasing interests specifically on habitat connectivity, where coral reef fishes migrate ontogenetically within the mangrove-seagrass-reef habitat mosaic (Mumby et al. 2004, Nagelkerken 2009). This further emphasized the importance of these coastal adjacent habitats in the tropics. A large-sized grouper, the orange-spotted grouper *Epinephelus coioides*, which has a high fishery value in the Philippines, exemplifies this behavioral trait (e.g. Mamauag et al. 2009).

3. Threats and Pressure

The Philippines has a large human population, which recently passed the 100 million mark and it is still growing without any sign of slowing down. Sixty percent of the inhabitants reside within 100 km of the coasts; hence, a significant proportion of the population is highly dependent on the resources found in the coastal areas. This increases the pressure on coastal ecosystems and jeopardizes their health and condition (e.g. Gjertsen, 2005). These pressures take the form of rising coastal development, increasing levels of pollution and sedimentation, and increasing densities of fishers, leading to overfishing and destructive fishing practices (Burke et al. 2012; MSN Threat Assessment Workshop 2014).

4. Climate Change

There is another form of threat that exacerbates the present situation in the Philippines: climate change. Increasing sea surface temperature (SST), frequent storms with highly variable tracks, and sea level rise are just some of the evident characteristics of climate change (e.g. IPCC Report 2012). Species found in coastal ecosystems have various degrees of sensitivity to variations in the climate (e.g. Cheung et al. 2009; Hoegh-Guldberg 2011, Munday et al. 2012; Lovelock et al. 2015) that indicates that they try to develop adaptation measures (e.g. Johnson & Welch 2009, Mamauag et al. 2013). Coral bleaching events have been occurring in the world (e.g. Hoegh-Guldberg 2007), including the Philippines. This was mainly attributed to the anomalous rise in the SST during the El Niño phenomenon in 1998 (e.g. Arceo et al. 2001).

5. Sea Level Rise and Mangrove Ecosystem

A topic relevant to this summit is the potential impact of sea level rise (SLR) to mangrove ecosystem. Alongi et al. (2009) offered the evidence that present human activities (e.g. deforestation and settlement) result in mangrove areas not able to keep pace with SLR; hence adaptation measures must focus on resolving these anthropogenic factors.

Mangrove habitats are vulnerable to SLR if the rate of soil elevation gain is lower than the SLR of the region (e.g. Lovelock et al. 2015). Soil elevation gain is attributed to local biological and geological processes in the area. Sediment supply, which can be sourced from the production of organic matter, or the lack of it caused by forest degradation, is a major factor that offsets SLR.

6. Vulnerability Assessment of Tropical Coastal Ecosystems

To address climate change impact and eventually attain resilient systems, the vulnerability assessment (VA) tools have been developed. These tools were developed to determine the sensitivity and adaptive capacity of the species, habitat, and social or institutional groups. A specific VA tool that mainly considers the tropical coastal ecosystem for climate change studies has also already been developed (Licuanan et al. 2015). This is known as the Integrated Coastal Sensitivity, Exposure and Adaptive Capacity for Climate Change (ICSEACC). Its vulnerability framework generally follows that of the IPCC (2001), with the vulnerability of systems or entities as a function of sensitivity (together with exposure will make up potential impact) and adaptive capacity. ICSEACC deals with several disciplines such as marine biodiversity, fisheries, socioeconomic condition, coastal integrity, and governance. This tool has been utilized to determine the vulnerability of coastal areas in the Philippines. Aside from knowing the vulnerabilities of sites, it also determines the adaptation measures that need to be taken, based on the scores and their corresponding management response, which are discipline-specific and site-specific. The major goal of the adaptation measures is to reduce the vulnerability of the sites through adopting and mainstreaming strategies that will lessen sensitivity (e.g. establish protected areas to decrease exposure to threats), and enhance adaptive capacity (e.g. provide capacity building mechanisms for the managers/stakeholders). The ICSEACC is relatively easy to use and permits participatory approach among stakeholders (e.g. local government officials). It aims to provide insights for resilient coastal ecosystems, by not only focusing on the biological and physical aspects, but also by addressing social inadequacies.

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