Contribution to GSDR 2015 – chapter 3

Vulnerability of Nearshore Ecosystems from Rapid Intensive Coastal Development

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Introduction

The Millennium Ecosystem Assessment pointed out that coastal systems are among the most productive systems in the world and are experiencing acute pressures from growing population and exploitation. It found that the greatest threat is development-related loss of habitats and services, while degradation from other exploitation also poses severe problems.

Over recent decades, the world as a whole has experienced fast economic development, especially in the developing countries. Extensive land reclamation has accompanied such development in coastal countries. For example, around the Yellow Sea, bordered by China and the two Koreas, 28% of its tidal flats existing in the 1980s had been reclaimed by the late 2000s (Murray et al., 2014). At the same time, as part of the significant growth of aquaculture in developing countries over the decades, mariculture has also undergone rapid expansion with no sign of peaking, supplying over half of world seafood demand (FAO, 2007 and 2014). However, marine aquaculture is largely confined to relatively small areas in coastal seas. For example, China's is credited with 63.3% and 54%, respectively, of the world's farmed marine food fish and aquatic plants production (FAO 2014). For such high production, nearly 1/3 of China's total intertidal wetlands and 10% of China's total nearshore water have been converted for mariculture use (MOA, 2014). Significant pressure from the combined effects of large-scale reclamation and mariculture have resulted in serious deterioration of the coastal ecosystems (CCICED Task Force, 2013)

Impacts from reclamation on coastal ecosystems and their services are largely known. However, rapid and large-scale reclamation has compounded and exacerbated these impacts. For example, the cumulative loss of China's coastal wetland area over decades has reached over 50% of its total (An et al., 2007). Such loss has caused significant coastal landscape fragmentation and loss of biodiversity, as well as destruction of habitats for fish and feeding grounds for shorebirds, leading to sharp decline of fisheries resources and bird species (Wang et al., 2014). China's large-scale reclamation has also resulted in the narrowing and even disappearance of gulfs and bays, leading to increased water pollution and frequent harmful algal blooms.

With mariculture rapidly growing into a global food-producing industry its negative effect on coastal ecosystems functions and services has also manifested. Ocean fisheries and mariculture share or compete for many coastal ecosystem services, including the provision of habitats and nursery areas, feed and larvae supplies, and assimilation of waste products (Naylor et al., 2000). Overfishing and large-scale reclamation combined have led to the collapse of regional wild fishery (Wang et al., 2014). The continuing expansion of mariculture will further exert tremendous pressure on habitats and nursery areas, detrimental to fisheries (Zuo and Lin, 2008).

The significant and deleterious environmental effects of the intensive and industrialized mariculture have been well recognized (e.g., National Research Council, 2010). One way to deal with the wastes from feed and excretion of the aquaculture is the so-called integrated multi-trophic aquaculture (IMTA), in which species of different trophic levels are raised together so that feed and wastes are recycled within the system (e.g., Barrington et al., 2009). Although met with wide enthusiasm the lack of thorough understanding of environmental impacts of IMTA is one major concern (e.g., IMTA White Paper, 2010). Large-scale IMTA in shallow bay will significantly alter the tidal currents, resulting in a reduced flushing capability of the bay and insufficient nutrient supply to the bay from the offshore water (Shi et al., 2011). In addition, organic wastes do accumulate in the sediments of IMTA area (Ren et al., 2014).

Direct release by mariculture of nutrients in the reduced form into ocean is of more concern (Bouwman et al., 2013). When the level of such nutrient is higher than the assimilative capacity of the marine area, it will stimulate blooms of algae on which mixotrophic HABs may feed (*op. cit.*). In turn, such HABs can kill or intoxicate the mariculture organisms and increase risks to human health. In fact, Northern China experienced brown tides, a form of such HABs, in consecutive years, the third country hit in the world but at much greater scale (Zhang et al., 2012). Large-scale mariculture activities were suspected to be the causes.

Aquaculture in general emits nitrous oxide, an important greenhouse gas with a global warming potential 310 times that of carbon dioxide over a hundred year lifespan. The global nitrous oxide emission from aquaculture could account for 5.72% of anthropogenic nitrous oxide emission by 2030 if the aquaculture industry continues to increase at the present annual growth rate (Hu et al., 2012). One other important known effect of mariculture is the yearly outbreak since 2007 of massive blooms of green tides (*E. prolifera*) associated with the large-scale *Porphyra* culture in Yellow Sea (Liu et al., 2009). At its peak offshore in 2008, the bloom covered an ocean of 1200 km^2 and affected 40,000 km^2 (*op. cit.*).

Rapid intensive reclamation and mariculture practice like those shown in the above examples will no doubt be replicated in developing countries around the world's coasts. Significant alteration of the nearshore ecosystems will be expected from this pending round of development. The fast pace of such coastal development will likely cause these ecosystems to evolve into states unfriendly to either the coastal communities or the ocean ecosystems at large. Much research is urgently needed to understand the changes.

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