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HUMAN INDUCED DEGRADATION OF COASTAL RESOURCES IN ASIA PACIFIC AND IMPLICATIONS ON MANAGEMENT AND FOOD SECURITY

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ABSTRACT

Currently, 41% of the world's total population and about a third of urban megacities are found within the coastal zone. The coastal watersheds and nearshore marine areas are the most productive and dynamic regions in the world. This strategic location for food, trade, commerce and tourism boasts more than half of the total service value of the global environment production. However, the changing environment also sports this area to be most vulnerable to human impacts such as climate change, pollution, coastal development, urbanization, fragmentation and degradation. The impact of these threats could hamper the millennium development goals of most Asia Pacific countries, producing hunger and poverty. Though fisheries resources were once abundant, the unsustainable practices of unregulated fishing gears, mesh net sizes and increased number of motorized boats have all fished the seas resulting to decreased predators in the food chain. Fishing employs more than 6 million fishers in the Asia Pacific and a primary source of livelihood for a majority of the population living in the coasts. The fisheries sector also plays a critical role in the economic, social and cultural developments of these nations contributing significantly (~12%) to their animal protein intake and 20% to their national GDP through export earnings. The coastal resources of Asia Pacific have an estimated total value of US$ 357 billion dollars but their value are fast declining due to a combination of rapid population growth, urbanization, coastal developments, overfishing and destructive fishing methods. Such declines have increased poverty among coastal fishers who are directly affected by changes in demography and development in the coasts.

Key words: coastal degradation, food insecurity, marine ecosystem, overfishing, Asia Pacific

INTRODUCTION

The degradation of coastal ecosystems poses a direct threat to human survival in many parts of the world and particularly in Asia and the Pacific where population is largely dependent on coastal resources. Currently, 41% of the world's total population and about a third of urban megacities are found within the coastal zone. Coastal resources are essential for food and income resources for most of the low-income groups. The coastal watersheds and nearshore marine environment serves as a hub for commerce, tourism, ports, industrial developments and food trades. It is one of the most productive and dynamic regions in the world. It is important to note that fish and seafood are the primary sources of food protein in this region of the world, with more than 12% of their protein consumption derived from fish and other seafoods (UNEP/COBSEA 2010).

This is because fish prices are relatively cheap compared to other regions of the world (Adeel & King 2002). Fishing and its related industries employ as many as 6 million in Southeast Asian countries and contributes up to 20% to the overall GDP (FAO 2009). The bulk of employment comes from various small scale fishing activities in nearshore coastal areas, in brackishwater aquaculture as well as from various support industries like fish processing, canning, transport and distribution. These supporting industries currently employ around 10 million people and increasingly, the aquaculture industry from shrimp, milkfish, tilapia and pangasius comprises the bulk of cultured species. With the rapid increase of population, the continual reliance on

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fish protein to sustain the nutritional needs of the people will continue. Growth in aquaculture will also expand as more and more people rely on fish as their source for alternative income and protein needs. Aquaculture is therefore viewed as a mixed blessing that offers alternative livelihood to many countries short of dollar and fish products are exported to other regions of the world, in particular, Japan, Western Europe and the US. However, because human activities in shores affect the health of coastal ecosystems mainly through destructive fishing practices and pond effluents from aquaculture, sometimes the ecological impacts more than outweigh the profits. Some types of fishing and aquaculture methods for example lead to degradation of many coastal ecosystems particularly by habitat destruction (mangrove clearance), waste disposal, introduction of pathogens and exotic species (Naylor et al. 2000). In association with this continued degradation of the coastal ecosystems, the health and livelihood of the people that depends on them are also compromised. Human malnutrition and food insecurity are two defining issues that are consequences of lack or inadequate food. Coastal areas are not only vulnerable from flooding and water borne diseases but the projected impacts of climate change, severe weather disturbance and rise in sea-level can further exacerbate the situation (UNEP/COBSEA 2010).

In the past two decades, the heightened demands for fish products led to several collapse of fisheries in various areas around the globe leading to a strong proposition by Pauly and others that fish decline is an evidence of stressed and overfished seas (Pauly et al. 1998). Today, ocean fisheries and aquaculture competes for many coastal ecosystem services such as provisions for habitat and nursery areas, feed and seed supplies and assimilation of waste products (Naylor et al. 2000). Because of high demand for shrimp and fisheries products, abandonment of aquaculture farms is not a choice or replanting of denuded mangrove areas are not being given high priority. Undoubtedly, shrimp exports are a lucrative business but its ecological impacts continue to haunt the fisheries sectors of the major aquaculture producing countries. For instance, about 4.2 million ha or 23% of the current global mangrove area have been lost due to a variety of reasons but primarily because of shrimp aquaculture (Talaue-Mcmanus 2000).

There is variety of reasons for the destruction of mangroves as cited in Table 1 such as pond culture, tree felling for woodchip and pulp production, urban development and human settlements, and harvest of products for domestic use. The impact of these activities is difficult to quantify for each country but nonetheless, shrimp culture remains to be the most pervasive economic imperative for mangrove conversion because of its high value in both the local and export markets.

Other threats to coastal marine resources include climate related variabilities like El Niños and severe typhoon disturbance. Reports on massive coral bleaching triggered by El Niño Southern Oscillation (ENSO) in 1996-1998 throughout the Pacific and Indian ocean was the strongest on record for Southeast Asia and the world with reported worldwide losses from this event that are estimated to be in US$700 million to 8 billion dollars over the next 20 years (Burke et al. 2002). Furthermore, a report on marine litter and coastal based pollution describes an increasing concern for human and economic losses amongst many stakeholders. In addition, the impending impacts of climate change particularly due to sea-level rise, saltwater intrusion, increasing temperatures and loss of wildlife habitat on coastal environment threatens this area which may produce ecological devastations yet unknown to man.

The agriculture and fisheries sectors are therefore the most vulnerable sectors facing severe water stress, salt-water intrusion, ground subsidence, extreme weather events, spread of diseases and food insecurity as food supply will likely be affected. The combination of these threats could therefore hamper the millennium development goals of most developing countries, producing hunger and poverty on global scales yet unseen. Summarized in Table 1 below are causes of habitat modification in nearshore aquatic and coastal ecosystems and their corresponding effects on biodiversity and services.

It is estimated that ecosystem goods and services provided by different coastal habitats of mangrove swamps, coral reefs, wetlands and seagrass beds in the Asia Pacific has a natural value that range from a low of US$ 7.7-86.3 billion (UNEP/COBSEA 2010) to a high of 357 billion dollars (based on estimates of Martinez et al. 2007). This natural capital may however perish in the span of few years due to rapid rate of degradation. Consider for example the alarming impact of human activities in coastal areas seen as percentage loss of the different habitats in selected Asia Pacific countries (Table 2). Indonesia which

has about 20-30% of the world's mangrove cover lost more than 1 million ha primarily due to cropland conversion, coastal development and conversion to aquaculture ponds (Giesen et al. 2006). Here we examine the alarming impacts of human settlements, urbanization and industrial developments with a focus on selected Asia Pacific countries on coastal resources. We will discuss the causes of habitat modification and its impact on marine living resources then we will also discuss the impact of extraction of these resources for food and economic reasons. Second, we will discuss the issues that are behind coastal degradation and third, we will propose some measures that could help provide solutions for these perennial problems. It is necessary that we examine historical data for biological sense as well as their socio-economic meanings in the light of people affected so that these issues are better dealt with relevance.

Table 1. Causes of habitat modification and its effects on marine resources

HABITAT	DIRECT CAUSES OF HABITAT DESTRUCTION	EFFECTS OF HABITAT DESTRUCTION
Mangroves	Mangrove conversion for aquaculture ponds, land reclamation, coastal developments such as human settlements, construction of ports, marinas	Removal of mangroves lead to loss of biodiversity, decline of fisheries productivity and removes an essential shield from tsunami
Coral reefs	Destructive fishing practices (muro ami, dynamite fishing, cyanide fishing), sand mining, coral mining, siltation, eutrophication, coastal developments, trampling from influx of tourists, climate change (abnormal warming & acidification of the oceans)	Reduction of coral cover due to disease, exploitation or trampling is linked to decline of fisheries, marine biodiversity, ecotourism, and consequent increases in algal blooms, jellyfish blooms
Seagrass beds	Siltation, pollution, eutrophication, coastal development, use of pushnets, bottom trawls	Loss of biodiversity, fisheries productivity, loss of nursery and feeding grounds for a number of fish species, dugong, marine turtles
Wetlands	Logging and woodcutting, land use change such as conversion for croplands, human settlements, and coastal developments	Loss of biodiversity, fisheries productivity, loss of feeding grounds for wetland and migratory birds

Table 2. Percentage loss or degraded habitats in selected Asia Pacific countries

COUNTRIES	MANGROVES[1]	CORALS (HIGH RISK)[1]	SEAGRASS[2]	WETLANDS[3]
Cambodia	28[a]	90	No data	30[d]
Indonesia	55	46	35	31
Malaysia	75	38	50[b]	71
Philippines	67	63	40	78
Thailand	84	51	25	22
Viet Nam	61[a]	49	45[c]	30[d]

[1] Burke et al. 2002
[2] Jiang et al. 2001
[3] UNEP 2004b
[a] Giesen et al 2006
[b] Bujang & Zakaria 2003
[c] UNEP 2004a
[d] ASEAN 2001

Causes of habitat modification and its effects on coastal resources

A. Degradation of Mangroves: The destruction of mangrove forests in the Asia Pacific stems mainly from its conversion for brackishwater aquaculture. It has since reached an alarming level primarily for the degradation of coastal habitats such as mangrove forests and seagrass beds and associated fauna. Although shrimp aquaculture is highly priced, the total value of returns of natural mangrove stands for its ecological services and sustainable coastal economics are higher (Primavera 1997; Primavera & Esteban 2008; Naylor et al. 2000) than when it is used for shrimp aquaculture, a cash crop among many developing countries in the Asia Pacific region (Table 3). More than 1.2 million ha of mangrove forests found in the Asia Pacific have been converted to aquaculture ponds (Giesen et al. 2006). Shrimp aquaculture developed in Southeast Asia through the use of earthen ponds and has since grown into a government and private sector initiatives. Because of high profitability and generation of foreign exchange, this provided the impetus for the global expansion of shrimp culture that resulted in the interests of national governments and international aid agencies.

This led to the massive decline of mangrove cover in Southeast Asia. For example, Indonesia lost 50% of its mangrove cover during the last fifty years due to aquaculture, cropland conversion, and logging (Sudara 1997; Giesen et al. 2006). Malaysia also lost approximately one third of the country's mangrove cover during the same period due to rapid urbanization and industrial developments (Sudara 1997; Giesen et al. 2006). While in the Philippines about more than a half have been converted to shrimp ponds during the initial success of shrimp aquaculture in the country (Primavera & Esteban 2008). Similarly, in Thailand about half of its original mangrove cover has been lost mainly for shrimp aquaculture (Flaherty & Karnjanakesorn 1992).

Vietnam lost most of its mangrove cover during the Vietnam War due to the use of pesticide (Hong 2000). Mangroves are known to provide ecological benefits such as of protection from erosion, flooding, typhoons, tidal waves and as spawning grounds for fisheries resources and stabilizing coastal regions (Primavera 2000; Danielsen et al. 2005). It is estimated that 90% of all marine organisms spends some portion of their life-cycle within mangrove systems (Adeel & Pomeroy 2002). Exports of leaf litter detritus from mangrove forests into the nearshore provide important nutrients for the trophic food-web and juvenile fisheries. In addition, they provide valuable ecosystem services that are essential for local communities such as wood for fuel and construction, food, medicine, and help contribute in biodiversity conservation through protecting juvenile fish and invertebrate species (Pritchard 2009).

Mangrove forests also act as a coastal shield from tidal waves, and erosion in coastal areas. The 2004 Asian Tsunami demonstrates how villages located behind mangrove forests have been spared the brunt of the assault with village houses remaining intact after being battered by the Tsunami due to wave attenuation (Danielsen 2005; Pritchard 2009). Mangroves also help filter and clean water by trapping sediments through their roots, and nutrients from leaf litter detritus are later exported and used by fishes, crabs and other organisms. Unfortunately, the conversion of large tract of mangrove swamps and wetlands for agricultural lands and aquaculture farms have altered coastal ecosystems and habitats, further contributing to ecological degradation. Degraded mangroves produce fewer benefits for fish, crustaceans and ultimately, humans. Because ecosystems are interconnected, the existence of a healthy mangrove results to healthy coral reefs and seagrass beds. Thus, it is vital that for aquaculture to be truly sustainable, it must not develop at the expense of ecologically important habitats such as mangroves and wetlands. However due to rising human pressure from fuel wood, fishing, building materials and aquaculture the mangrove forests in Asia Pacific are predicted to continue declining unless local governments and village folks support their sustainable use and reforestation.

It has been suggested that for every hectare used for aquaculture ponds, 4 hectares of mangrove forests should be left intact for this ecosystem to remain functional and healthy (Primavera & Esteban 2008). There are more than 70 mangrove and associated species in the world, more than half of these occurs in Indonesia alone, and about 40 percent of all mangroves occur in Asia, including Australia (Table 4; Spalding et al. 1997). In several Asian countries mangrove loss has exceeded 60 percent, on average, in recent decades, while the total area has decreased to less than 15 million ha worldwide from an estimated 32 million ha originally. Globally, mangroves provide more than 10 percent of the essential dissolved organic carbon that is supplied to the ocean from land (Dittmar et. al. 2006), yet less

Table 3. Past and present mangrove cover, brackishwater ponds and shrimp aquaculture production and export value in selected Asia Pacific countries.

Country	Past cover[1] (ha)	Present cover[1] (ha)	Brackishwater pond (ha)	Shrimp/Prawn aquaculture production[2] (tons) 2008	Shrimp/Prawn export value[2] (US$ x 10^3) 2006
Cambodia	83,000	<60,000	850	75	11,520
Indonesia	4.25 million	2.5 million	438,010	408,346	1,244,876
Malaysia	670,000	570,000	5,100	51,047	319,605
Philippines	450,000	120,000[a]	232,000[a]	48,199	141,475
Thailand	367,900	167,582	253,000	507,500	2,429,817
Vietnam	408,500	155,290	220,000	381,300	1,631,705

[1] Giesen et al. 2006
[2] FAO FIGIS 2011
[a] Primavera and Esteban 2008

Table 4: Extent of coastline, coastal biodiversity, and natural values of ecosystem goods and services in selected Asia Pacific countries

Country	Coastline[1] (km)	Mangrove[2]	Hard coral[3]	Sea-grass[1]	Fish[2]	Natural value[4] (US$ x 10^6 $year^{-1}$)		
						Terrestrial	Aquatic	Total
Cambodia	1,127	5	111	1	128	3,077.25	763.57	3,840.82
Indonesia	95,181	45	590	13	4080	154,563.42	123,200.30	277,762.72
Malaysia	9,323	36	400	12	368	22,241.84	8,113.89	30,355.74
Philippines	33,900	30	464	19	952	4,719.45	18,396.73	23,116.18
Thailand	7,066	35	250	15	308	9,502.02	3,940.87	13,442.89
Viet Nam	11,409	29	400	9	257	4,823.53	4,186.91	9,010.44

[1] Burke et al. 2002
[2] WRI 2003 data
[3] UNEP 2007a
[4] Martinez et al. 2007

than one percent of the world's mangroves are adequately protected.

B. Destruction of Coral reefs: Over 80% of coral reefs in the Asia Pacific region are at risk and over half (56%) are at high risk (WRI 2000). Coral reefs and coral reef fishes are essential for fisheries, tourism earnings, aquarium fish trade, sandmining and bioprospecting for commercial uses like pharmaceauticals. The coral reefs of Southeast Asia are one of the most biodiverse and most threatened of any region. The combined effects of destructive fishing, overfishing, eutrophication and sedimentation are the most pervasive threats affecting the health of coral reefs (UNEP/GEF 2005). The indirect causes of these threats are high demand for food, coastal development, deforestation and unsustainable tourism.

More than 77 % or an estimated 800 species of reef building corals species thrive within the waters of Southeast Asia (Table 4; Burke et al. 2002). For thousands of years, people and corals coexisted together, but with coastal population ballooning to more than 350 million people within 100 km of the coast, these communities are at risk from declining fisheries yield, eutrophication and increasing sea-level rise and water stress. Coral reefs are vital for the healthy functioning of the ecosystems and economic well-being of these nations. Reef fisheries employ people and provide food for most of the rural coastal populations. It also generate billions of dollars for the live food fish trade, the ornamental trade, and local subsistence fisheries with an annual estimated US$2.4 billion per year for Southeast Asia (Burke et al. 2002). Coral

bleaching is considered a serious natural threat to coral reefs in the region. But few coral reefs in Southeast Asia remain unaffected by human activities, even those in remote locations. Even reefs found far from human habitation such as the Spratly islands, Tubbataha, and eastern Indonesia is threatened by human activities such as destructive fishing practices. Coral reefs face unprecedented threat from the combination of rapid population growth, destructive fishing practices, natural climate variability and over-extraction of reef resources. This human pressure creates unsustainable demand on both terrestrial and marine living resources that continue to jeopardize their incredible value, existence and ultimately the economy of the region. The most prevalent threat is over-exploitation and with rapid population growth in coastal areas, this creates enormous fishing pressure. With lack of alternative employment, training and few incentives, fishers do not bother to leave the industry despite chidings by fisheries authorities.

Furthermore, the increasing demand by developed countries for fish, shrimp, live reef fish, coral reef associated products continue to inflate demands that lead to widespread target species overfishing by many local firms. The lack of political will to implement laws and open access by commercial and foreign vessels in most Asia Pacific countries continue to hamper the efforts to ban illegal and destructive fishing techniques. Fishing practices like the use of dynamite, fine mesh nets and cyanide to harvest and stun fishes not only destroys the fish but also the natural resource base for future fishing and with detrimental effects across the ecosystem. Because overfishing has been occurring for several years now in most of the region, fishing has become unsustainable in most areas and needs closing if the stocks are to be replenished. This has massive implications for the food security of the region, especially in coastal areas which are highly dependent for fishing to survive and augment their income.

In addition to these issues, massive deforestation in Indonesia, the conversion of mangroves to brackishwater ponds in Thailand, the Philippines and Indonesia as well as rapid industrial developments in Singapore and Malaysia has contributed to the growing concern that coral reefs are dying from increased sediment and nutrient loads due to siltation and eutrophication dumped in coastal areas. The untreated sewage or inadequate water treatment plants has also substantially increased over the years and dumped to open waters. These anthropogenic impacts are causing the massive overgrowth of algae in many coral reefs. A major challenge among the countries is to find a solution on how to manage development alongside maintaining a healthy ecosystem. In addition to human induced alterations on coral reefs, natural factors that contribute to massive damage can also be caused by typhoons or severe weather disturbance, diseases, sea-level rise, sand scouring and other natural hazards. Coral bleaching events for example have destroyed an approximately 16% of coral cover worldwide during the 1998 El Niño (Wilkinson 2000) and accelerated pathogen infection on a number of corals (Harvell et al. 2002).

C. Removal of Seagrass beds: The removal of seagrass beds is mainly due to rapid urbanization, coastal developments, siltation and eutrophication owing to the rapid increase of population in many coastal areas. This puts elevated pressure on resources which leads to degradation of resources. In the Asia Pacific countries, there has been an elevated rate of seagrass loss and depletion. In recent years, Indonesia has lost about 30-40% of its seagrass beds, with as much as 60% being destroyed around Java; Thailand lost 20-30% of its seagrass cover while in the Philippines, it is about 30-50% (see Table 2; UNEP 2004a). There is a dearth of information on status and trends of biodiversity, taxonomy or depletion of seagrass available for Cambodia, China, Malaysia, and Vietnam. In general, most of the losses of seagrass beds in the region have been attributed to wastewater discharge, untreated sewage, shrimp farms, trawlers and their use of push nets and dragnets (Sudara 1999). Seagrass beds are sensitive to light reductions so that increased sediment and nutrient loads coming from human activities adjacent the shore and on the shore have consequent effects on the healthy functioning of seagrass beds. Construction activities such as hotels, residential lots, ports, marinas as well as mangrove conversion for aquaculture ponds invariably results to development of eutrophic and polluted waters where no seagrass species survives in the long run.

The benefits of seagrass are largely undervalued and unappreciated in many coastal areas around the world so that this has led to unrestricted developments in many shores without considering its impacts on seagrass ecosystesm. For instance, the economic return of seagrass beds found in the region according to a recent regional assessment was only US$ 87 million dollar per

year compared to Costanza's US$1.6 billion dollar per year (Table 5; UNEP/COBSEA 2010). The main difference though was the focus of the assessment which was valuation of coastal habitats based on direct uses and not mainly on services (UNEP 2007b). Because the economic return from seagrass beds in Asia Pacific is very poorly known, we can take the assessment of the economic value of the world's ecosystems by Costanza et al. (1997) to be a conservative estimate of the priceless treasure that they are and often taken advantage by man. For instance, they priced the nutrient cycling function of seagrass beds at a whopping US$3.8 trillion, the second highest value among all the other ecosystem values they listed.

Thus, the real importance of seagrass beds may not actually be on its direct uses by man, but on its ecological services which are vital for the healthy functioning of other ecosystesm such as coral reefs, mangroves and ultimately the fisheries. Seagrass beds are known feeding grounds of adult and juvenile fishes, sea cows (*Dugong*) and marine turtles. There are estimated 318 fish species and 51 families that are associated with seagrass beds (Talaue-McManus 2000). In addition, the famed seahorses which are associated with seagrass beds and corals are under severe threat from aquarium fish trades as well as due to depletion of their habitat. The ecological functions and services of seagrass beds are varied, these plants help bind and trap sediments through their roots thereby stabilizing bottom sediments, help maintain water quality, reduce wave energy, serves as breeding, nursery and feeding grounds of various fishes, shrimps, seacows, seahorses and marine turtles (UNEP 2004a). These are vital in maintaining coastal biodiversity and fisheries. On a global scale, seagrass, which occupies more than 600,000 km^2 mostly in continental shelf contributes 12% of the total carbon storage in the ocean (Duarte & Cebrian 1996). There is however no present estimate for the total carbon storage of seagrass beds for the Asia Pacific region but are considered to sequester a sizable amount based on seagrass coverage in the area.

Because most land-based pollution is discharged into the coastal zone, water quality rapidly deteriorates, affecting seagrass beds. When raw sewage or other land based pollution such as sediments and fertilizer run-off is discharged into the sea, seagrass beds are directly affected. But it is the continued decline of coral reefs (which act as buffer against waves) and mangroves (which act as a filter for sediment loads from land) in the region that primarily contributes to the worsening quality and depletion of seagrass beds. Quite naturally, coastal development and urban expansion have also further worsened the situation.

Of the approximately 60 seagrass species described worldwide, 19 species are found in, and adjacent to, the coastal waters of the Asia Pacific region (see Table 4). Many of these species have already been described, while taxonomic work on other species are ongoing. Estimaes of seagrass loss in Indonesia, Malaysia, Philippines, Thailand, and Vietnam are shown in Table 2, although this may be an incomplete listing or may not fully describe the full status of the said ecosystem, this gives an estimate of decline in the Asia Pacific. The number of seagrass species found are as follows: Cambodia, 1; Indonesia, 13; Malaysia, 12; Philippines, 19; Thailand, 15; and Vietnam, 9, respectively (Burke et al. 2002).

The genus *Halophila* is the most diverse genus in the region and is known to occur in coastal waters throughout the region. Further taxonomic work is essential to verify the description of species in this seagrass genus in the region. Associated organisms found in seagrass beds worldwide include 450 algae, 171 polychaetes, 197 molluscs, 15 echinoderms and 215 fish (Spalding et al. 2001). In the region, selected demo sites during the South China Sea seagrass assessments show that there are at least 25 species of epiphytic algae, 21 macrobenthic algae, 10 penaeid shrimps, 100 gastropods 5 siganids, 7 sea urchins, and 7 seahorses (UNEP 2004a). Most of the major commercial fisheries of the region occur immediately adjacent to seagrass beds (Fortes & McManus 1994).

D. Conversion of wetlands: Almost half of the world's largest cities lie within 50 km of a coast. Rich coastal areas provide food, recreation, and transportation, and serve as huge biogeochemical processors (Vörösmarty et al. 2009). These areas are experiencing increasing pressures from the land side, as populations grow and coastal wetlands are lost to agriculture and urban expansion. At the same time, creeping inundation is eroding coastlines on the ocean side (Vörösmarty et al. 2009). Many of the world's largest deltas are densely populated and heavily farmed. Nevertheless, they are increasingly vulnerable to flooding and conversion of land to sea. A recent study found that 24 of the 33 largest deltas are sinking and that all but five have

experienced temporary flooding in the last decade. Tens of millions of people have been affected and a total of 250,000 km^2 has been inundated (Syvitski et al. 2009). Deltas are at risk from sea-level rise, and direct human activities have significantly increased the vulnerability of deltas. Dams and reservoirs, for example, interrupt the natural flow of rivers and keep sediments from reaching the deltas. Wetlands are defined as "areas of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters" (Ramsar Convention 1971). This definition encompasses reef flats and seagrass beds in coastal areas, mudflats, mangroves, estuaries, rivers, freshwater marshes, swamp forests and lakes, saline marshes and lakes as well as underground water resources.

About 6% or 5.7 million square kilometres of the Earth's surface is wetlands. The greatest proportion is made up of bogs (30%), fens (26%), swamps (20%) and floodplains (15%), with lakes accounting for just 2% of the total. Mangroves cover about 240,000km^2 of coastal area and an estimated 600,000km^2 of coral reefs remain worldwide (WCMC 1992). About 56% of wetlands are found in tropical and subtropical regions and almost 1/3 are located in Asia (Mitsch & Gosselink 2000). Wetland ecosystems are cradles of biological diversity. Countless species of plants and animals depend on them for survival. Fishes in wetlands number around 20,000 species worldwide. Diversity amongst aquatic species groups is highest in the tropics: South America has the most species with 2,220 species, of which more than 1,000 are in the Amazon River basin; Africa has 2,000 species, with more than 700 occurring in the Zaïre River basin; Europe has about 200 species; and, Asia has an estimated 1,600 species but this number is increasing as additional research is undertaken (WCMC 1992).

The Southeast Asian region is rich in marine biodiversity. Field records of hermatypic coral genera indicate that Indonesia, Malaysia and Philippines form the centre of coral diversity. Countries bordering the South China Sea largely depend on wetlands for their livelihood. In Cambodia, Over 30% of its territory is wetlands. Following internationally accepted criteria for wetland identification (defined by the Ramsar Convention), over 20 % (36,500 km^2) of the Kingdom may be classified as wetlands of international importance (UNEP 2004b).

Despite the importance of wetlands of high biodiversity in the South China Sea, loss and degradation of wetlands and their biodiversity have been continuing at a high rate due to the increasing human population size, particularly in coastal areas, poverty, and people's dependency on wetland resources.

Actions are urgently needed to halt the degradation of coastal wetlands around the South China Sea. Wetlands are the ecotone and buffer zone for inland and marine habitats with great importance for their "ecological functions," that support economic activities of significant value. These ecological functions include regulation of water regimes; flood buffering and control; groundwater recharge and discharge; wind breaks and storm protection; shoreline stabilization and erosion control; retention of nutrients, sediments and contaminants; nutrient processing, provision of nutrient-rich and sheltered habitats, spawning and nursery areas for fish and aquatic organisms; retention of carbon dioxide and regulation of local and global climates. However wetlands have been lost or altered because of the disruption of natural processes by agriculture, aquaculture, port and harbour development, human settlement, tourism, urbanization, pollution, water transfer, dam construction, and other forms of intervention in the ecological and hydrological systems.

For instance of the 27 million ha of peatswamp forests originally found in Indonesia and Malaysia, 13 million ha (48%) have been intensively logged and drained for agricultural, aquacultural and human settlement. The destruction of peatland is causing the release of an estimated 2000 million tons of CO_2 per year, or an equivalent of 8% of all global fossil fuel emissions (Wetland International 2011). In addition to these, the degradation of wetlands could also be the result of overfishing, destructive fishing practices, deforestation, natural calamities or severe storms and weather disturbance. There are a total area of 4,187,279 ha of the five specific types of wetland sites identified in the region, specifically lagoons (34,921 ha), estuaries (1,203,871 ha), inter-tidal flats (691,859 ha), non-peat swamps (1,623,567 ha), peat swamps (646,927 ha).

Extraction of resources

Overfishing: A study on the coastal fisheries of the Asia Pacific region concludes that the area is highly overfished and depleted with fish stocks (Stobutzki et al. 2006). An urgent attention to reduce fishing capacity and find alternative livelihood, retraining and re-

education of many coastal barangays or villages should be undertaken coupled with effective establishment of fish refugia or no take reserves. The six countries under focus of this study have a combined population of more than 350 million, about 73% of which are found in coastal areas with a significant proportion of the population living below poverty line approaching more than 130 million (Table 6). Poverty in rural areas is more severe than the national average, ranging from 18% of the rural population in Malaysia to 51% in the Philippines (Silvestre et al. 2003). Coastal fisheries are particularly important in rural, coastal areas where the sector contributes substantially to food security and social stability of the poorest segment of the population. In terms of fish aquaculture production, four countries from Asia Pacific provide the world with a combined total production of 5 million tons, or 10.4 % of the current world production of 52 million tons (FAO 2009). The Asia Pacific (excluding China) currently produces over 23% in quantity and 28% by value of its aquaculture; while its total capture production amounted to more than 6.5% of the world's total of 92 million tons (Table 6; Figure 1). The fisheries sector contributes a sizable percentage to the GDP of most of the developing countries in the Asia Pacific region, 10% for Indonesia, 11% for Malaysia, 19% for the Philippines, 15% for Thailand, and 40% for Vietnam (Stobutzki et al. 2006).

The total fisheries export value for each of these countries constitutes a large amount of their dollar earnings as more than 50% is exported to developed markets such as Japan, Korea, China, Australia, Western Europe, and the United States (FAO 2009). Total export value for the fisheries commodities of the selected Asia Pacific countries registered (in US$) 48 million for Cambodia, 1.8 billion for Indonesia, 616 million for Malaysia, 348 million for the Philippines, 4.5 billion for Thailand and 2.7 billion for Vietnam (Table 6). In total, Asian countries accounted for 52% of the global capture production of 92 million tons in 2006 (FAO 2009). Although this is much, fish production in countries must be examined not only in biological terms but also from the social and economic context of the region. Most of the Asia Pacific countries are still regarded as low to middle income economies with fish and fisheries playing an important role in food security, nutrition and income generation. It provides a vital source of protein contributing more than 30% of the animal protein intake among such countries as Cambodia, Indonesia, Malaysia, Philippines, Thailand and Vietnam (Table 6). Therefore, as population grows, the demand for fish as food will radically impact the food supply needed to sustain such population growths. Because the global capture fish production has plateaued to 80 million tons and drastic declines in recent times of many fishing areas shows no levelling off, the assessment of resources and management of remaining fishing areas for sustainable harvest should be facilitated by governments. Overfishing compounded by environmental problems such as pollution (primarily eutrophication) in most coastal areas chiefly contributes to this drastic decline of fish production. An analysis of the fisheries sector in the region shows trends of overfishing that is due to destructive fishing practices (Talaue-McManus, 2000). Inappropriate fishing methods and gears kill both juvenile and adult fishes as well as their habitat which could threaten not only food security but also the biodiversity of the area, affecting both man and resources in the long term. Damaging technologies that are used to exploit juvenile and large fishes as well as their habitat include: a) trawling that damages seagrass beds, corals and causes water turbidity, b) fine mesh nets that kill all fish leaving none to spawn, c) blast and cyanide fishing that destroys corals, seagrass beds, larval and juvenile fish as well as invertebrates, d) motorized fishing bancas that cause noise and pollution. In whole, although the catch has not yet been totally depleted in regional waters, fishers are nowadays finding fewer catch per trip into the sea and with decreasing sizes (Silvestre & Pauly 1997a, 1997b). If the local governments will not intervene and put up "no take" fish reserves, this could lead to empty oceans that can trigger malnutrition and hunger in the population.

B. **Poverty:** The drastic declines in coastal fisheries are also intimately interlinked with another major regional issue - poverty among fishing communities. Poverty is regarded as pervasive in small-scale fisheries and small-scale fishing is often cited as an income of last resort for the poorest of the poor (Townsley 1998; FAO 2000; Bene 2003). Poverty in fisheries is often characterized by lack of basic necessities, low level of education, cramped living space that makes them vulnerable to accidents and natural disasters (Townsley 1998; Greboval 2002; Alison & Horemans 2006). This condition does not allow them reprieve or to have many choices in life.

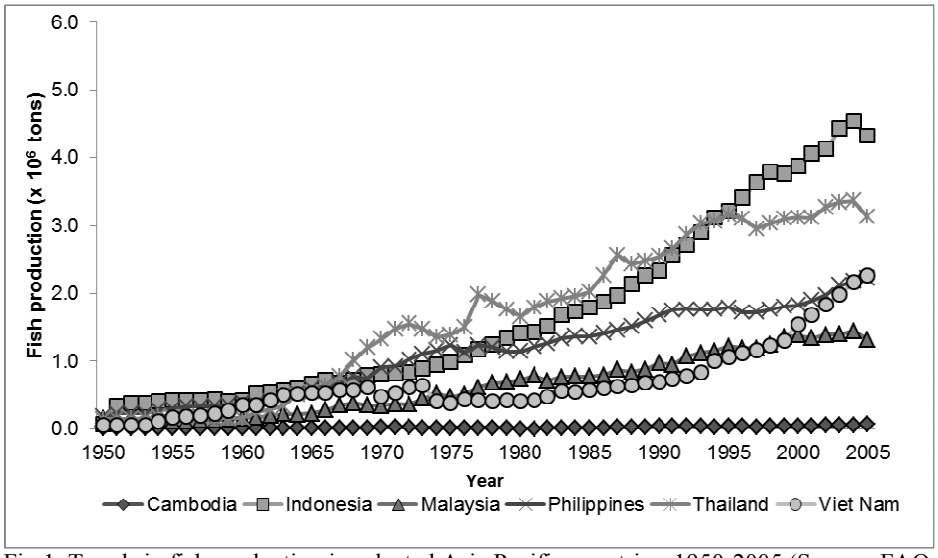


Fig 1. Trends in fish production in selected Asia Pacific countries, 1950-2005 (Source: FAO 2007)

The impacts of depleted fisheries, and degraded coastal habitats can fundamentally affect the viability of their livelihoods. For instance, the declining biomass stocks in Manila Bay and the Gulf of Thailand are causing fishers to increase their fishing effort, use unlawful fishing methods or expand beyond municipal waters to fish down the food web with increasing number of invertebrates such as squids, jellyfishes, shrimps and lobsters caught in their nets while catches of demersal and small pelagic fishes have drastically declined (Pura et al. 1996; Barut et al. 1997; Krongprom et al. 2003). Although fisheries remain profitable, this is only true for large commercial vessels that employ few people and catch more fishes offshore.

However, for the small scale fishers, they hardly earn a living and are often marginalized with the proceeds unevenly distributed among owners of boat-gear and ordinary laborers (Charles 2001; Salas et al 2007). These issues have important implications for the sustainable management of coastal resources and sustenance of livelihood of the coastal fishers and their families in the region (Silvestre et al. 2003). It is a commonly known that unless one provides a solution to the impoverished condition of fishers and their families in the region, over-exploitation of resources cannot be avoided (Fig. 2). Rampant poverty drives more people into fishing as the last resort to lift their hunger keeping them dependent on the sea for sustenance and living (Matthew 2003). Thus, sociocultural factors play a key role in keeping people chained to fishing for life (Bene 2003; Cinner et al. 2009).

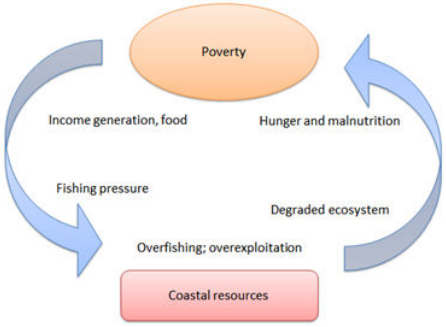


Fig. 2. Limited coastal resources remain threatened unless poverty is addressed with a holistic approach that solves the main driving factors for fishing and ecosystem degradation.

Although there seems to be no easy answer to driving poverty away from present coastal populations, addressing their basic needs and how to meet them could make a difference in the lives of the people. Targeting this group of people for assistance and aid via education, financial package, and diversified livelihood are needed if poverty traps are to be broken (Costanza 1987; Rosegrant & Hazell 2001; Cinner et al. 2009). Raising awareness and putting environmental education as a core program in learning institutions and among local governments could make a difference in fishing communities (Hopkins & McKeown 2002; Allison & McBride 2003). There is a need for educational reform to improve the natural resources management in many developing countries and this begins with higher education institutions that provide innovative educational programs that impart new skills and knowledge to students in

partnership with the fishing communities (Allison & McBride 2003). By empowering the local people through access to education, trainings savings and loans, fishing gears and techniques and livelihood diversification, the risk or vulnerability of resource degradation is minimized (Bloom et al. 2003; Allison & Horemans 2006; Cinner et al. 2009). This cyclic dependence in the life of a fisherman can be broken as illustrated below (Fig. 3).

Fishing effort increases as population grows in the coastal areas due to more mouths to feed, and more needs to be met, unless these families have other means to obtain expendable income. Due to impoverishment, fishers are often adamant to risk their trade for another form of livelihood unless they could obtain enough money to feed their families; they require a big push or positive shock to escape their trap (Bloom et al. 2003; McClanahan et al 2005; Cinner et al. 2009). An innovative or skills based training could be one such answer to raise the level of education and add new skills to fish farmers could help them find other employments. Significantly, the socio-economic context on how alternative interventions should be adopted must be based on the actual condition of the fishers. Providing alternative jobs that does not give the same noneconomic satisfaction as fishing does could fail and make fishing otherwise more attractive through social packages to fishers than other sectors could also backfire and attract new fishers instead, making it worse than the first (Allison & Ellis 2001; Pollnac et al. 2001, 2008).

Fisheries management issues

There are many issues that are commonly cited in coastal fisheries, but most are interrelated, including their consequences. Below (Table 7), a summary is provided of the major issues that affect many of these countries, including their underlying causes, consequences and some solutions. The documentation of these issues are varied and numerous especially in South and Southeast Asia (Chua & Scura 1992; Hotta 1996; SEAFDEC 2001; Silvestre & Pauly 1997a). Here we briefly present the four main issues that often remain unsolved due to lack of effort from authorities who otherwise are to safeguard their resources for the common good. The consequences of these issues will always lead to a depleted state of coastal fisheries and destruction of marine resources that can be due to overfishing, destructive fishing, inappropriate fishing methods, habitat degradation or pollution. When fisheries resources decline, fishers try to remedy this by increasing pressure on the resource through a more efficient gear or increasing effort to take more fish from the sea, resulting to a more dismal state (Pauly 1990; Allison and Ellis 2001; McClanahan 2005).

A. Weak law enforcement: Because the economic state of most countries in the region are from low to middle income, budgetary deficits are chronic issues and complaints of out-dated equipment to chase illegal fishers and poachers are mounting. This insufficient enforcement results to proliferation of illegal activities such as

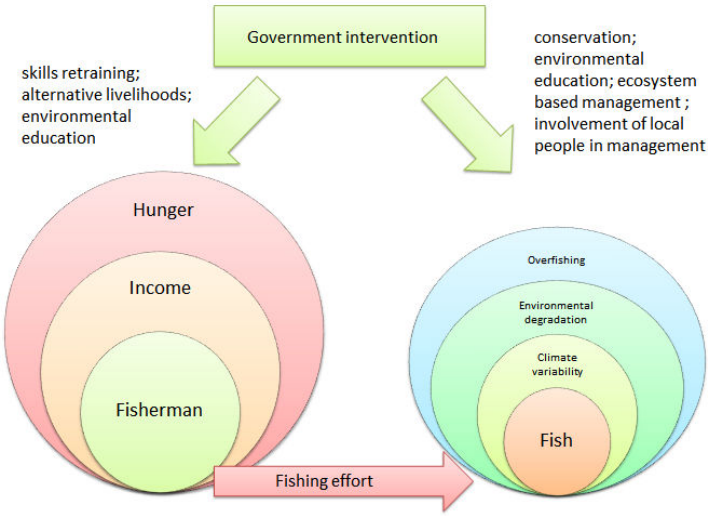


Fig. 3. Major factors that motivate fishers to extract limited fisheries resources and main causes of rapid decline of fisheries and roles of government institutions (see text for further explanation).

Table 7. Major issues in coastal fisheries in the Asia Pacific region

MAJOR ISSUES	CAUSES	CONSEQUENCES	SOLUTION
Weak law enforcement	Inadequate local government support/equipment e.g. lack of fast boats to apprehend poachers/illegal fishers	Depletion of coastal resources; overfishing	Strengthen inter-agency cooperation and contact/define job descriptions of agencies in the area
Inadequate policies	Inadequate inventory or research on coastal resources	Degradation of coastal environment; pollution, fragmentation	Tie-up with local universities/NGOs for assessments and inventories
Lack of compliance with regulations	Weak coordination/low level participation of stakeholders	Reduced catch	Strengthen inter-agency cooperation and contact/explain and implement laws that apply to the community in a seminar for them to become better informed
Weak to non-existent conservation efforts	Weak coordination/Inadequate awareness campaign	Lost revenue; Poverty; Intersectoral & intrasectoral conflicts	Tie-up with local universities/NGOs for information campaign/Do participatory rural appraisal for people to become more aware of their resources

encroachment of illegal fishers into areas reserved for fish refugia, marine sanctuaries, encroachment of commercial fishing vessels into areas reserved for artisanal fishers, blast and cyanide fishing, violations of mesh size regulations and operation of unlicensed boats. The weak law enforcement is linked to other institutional weaknesses such as the low level of stakeholder participation in management.

Inadequate policies: Most countries have varying fisheries and environmental laws and policies but the inadequacy of these policies becomes obvious when development is prioritized at the expense of degradation of the environment. This occurs for example when mangrove clearance is given priority to develop a resort or coastal residential areas rather than locating these to other areas. Further, some countries subsidize the fuel of their fishing fleets, keeping them longer at sea to increase fishing efforts. The lack of information concerning the consequences of these aberrant acts should be examined and local universities, including some NGOs can be tapped to help draft better policies that reflect an ecosystem-friendly stance. This also helps remedy any lack of policy skills on the part of government authorities and removes any discrepancies in their adopted policies.

B. Lack of compliance with regulations: Although free enterprise can be encouraged in a democratic society, the view that every resource is common and for take should diminish, partly because this breeds irresponsible exploitation. Since human is territorial by nature, vague definitions of territory or fishing grounds or fish quotas only exacerbates overfishing. Government regulation is always needed where people tend to forget the finiteness of their resources. The lack of compliance however can be traced on the government's failure to use its power to punish those who abuse or violate the law. Most fishers resist any regulatory measures regardless of who is speaking because they live to gather for more every day. To remedy such issues, strong interagency participations to punish those who violate the law should be sought as well as provide free seminars on the importance of regulating the fisheries for the common good of all.

C. Weak to non-existent conservation efforts: To facilitate conservation in the fisheries there is a need to continue to remind communities of the importance of putting up marine reserves, fish refugia and training them how to manage their fisheries well. Local governments who lack support funds or unable to do their own campaigns should tap the help of NGOs as well as local universities to help them. As a whole, weak inter-agency coordination can lead to contradictory law

enforcement or inefficient use of limited resources. For example, in the Philippines, the wave of aquaculture campaign for food security in the 1980s and 1990s resulted to failed national conservation efforts. Because man is territorial and motivated to survive, food was given importance without knowledge on the consequences of mangrove and forest clearance in many coastal areas that eventually destroyed these valuable resources. Instead of proclaiming a balanced growth in aquaculture and at the same time mangrove reforestation and reserves, the country failed to stop the shrimp fever until a virus did. Given the limited resources available in these countries, efficient inter-agency coordination and cooperation with NGOs and local universities which can provide technical assistance should lead to a more effective use of the resources.

CONCLUSION

The result of human induced coastal degradation in Asia Pacific countries have led to the destruction of natural fish habitats and coastal resources that suffers from chronic over-fishing and pollution. Coastal resources of the countries assessed have an estimated total value of US$ 357 billion dollars but their value are fast declining due to a combination of rapid population growth, urbanization, coastal developments, overfishing and destructive fishing and weak law enforcement as well as lack of adequate information on status of resources and their value. Such declines have increased poverty among coastal fishers who are directly affected by changes in demography and development in the coasts. To address this downward spiral and restore the ecosystem, a two- pronged approach that addresses long term and short term needs of coastal fishers are urgently required to reduce poverty among fishers and sustain the contribution of coastal fisheries to the economies of developing countries. There is a need to focus on giving access to education for the children and families of coastal fishers or giving them additional social benefits such as loans for alternative livelihoods that could push them out of their proverty and increase their adaptation and resilience to risks and vulnerabilities in the environment. Owing to the technical, personnel and financial constraints faced by many Asian countries, efforts to manage and mitigate major issues affecting coastal areas will largely depend on pre-identified interventions that will lift them from poverty and put a reprieve on the environment. Sustainable development is after all a cooperative effort between a pro-active government and a willing people to adapt and change.

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