Ecosystem Services for Poverty Alleviation: Marine & Coastal Situational Analysis

Appendix 3

South East Asia Regional Assessment and Institutional Analysis

submitted by:
The WorldFish Center

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1.1 Background

This Regional Assessment report is one of two regional assessments that form part of a *situational analysis* that aims to assess the dynamics of change in ecosystem services (ES) associated with marine and coastal systems, and to identify how they support the livelihoods and well-being of the coastal poor. It will identify the key challenges for research and current gaps in knowledge and capacity in order to inform the development of a research strategy to support the maintenance of ecosystem services explicitly for poverty alleviation. The two regions are Southeast Asia (SEA) and the Western Indian Ocean (WIO).

This report fulfills the assessment for the SEA region.

1.1.1 Defining coastal and marine ecosystems

For the purpose of this SEA assessment, the definition of coastal and marine ecosystems was adopted from the Millennium Ecosystem Assessment work (see Ecosystems and human well-being: Current state and trends, Chapter 19, page 516). The coastal and marine ecosystems constitute terrestrial ecosystems - areas where fresh water and salt water mix, nearshore coastal areas and open ocean marine areas. The coastal systems are where people live and where a spate of human activity affects the delivery of ecosystem services derived from marine habitats. The marine fisheries systems are places that human relate to and affect mainly through fisheries extraction.

1.1.2 Purpose of the assessment

The purpose of this SEA regional situation analysis is to:

1. Identify the status and condition of the coastal and marine ecosystem services within SEA region
2. Identify the status and condition of poverty within the SEA region
3. Identify the linkages between coastal and marine ecosystem services and poverty alleviation within the SEA region
4. Identify knowledge management issues and make recommendations on key researchable issues.

1.2 Methodology

1.2.1 Country focus

This regional assessment report has adopted the Southeast Asia regional characterization set by the Asian Development Bank. Southeast Asia is a sub-region of Asia consisting of two geographical regions: the Asian mainland and maritime area consisting of island arcs and archipelagoes. The mainland section comprises Cambodia, Lao People's Democratic Republic, Myanmar, Thailand and Vietnam. The maritime section consists of Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore and the latest addition is East Timor (which formerly was under the sovereignty of Indonesia).

All 10 countries (with the exception of the newly independent East Timor) are members of the Association of Southeast Asian Nations (ASEAN) which was established since 1967. Going by their popular slogan of 'ten nations, one community', ASEAN members have active development relationships that relate to macro-economy, trade, investment, transport and communication, tourism, manufacturing industry, agriculture, health, education and other sectors of development.

For the purpose of this Regional Assessment, a regional review of coastal systems and a detailed review on the marine fisheries systems encompassing South China Sea and Sulu-Celebes Sea were undertaken[1]. Case studies focused on the Philippines, East Malaysia of Malaysia and Vietnam, for three

[1] It should be noted that East Timor was not assessed as an independent country in this Regional Assessment report. Most secondary data collected dated back to 2005 and earlier. Hence, the data compiled and synthesized in this Regional Assessment report did cover East Timor, but these are aggregated under the country heading of Indonesia.

main reasons: (1) all three countries/states contain the highest and most diverse coastal and marine ecosystems; (2) the coastal stretches of these countries/states are highly populated; and (3) naturally high numbers of people depend on the coastal and marine ecosystem services for their day to day living including employment, food, housing and recreation.

1.2.2 Method

This Regional Assessment involved two primary methods of data collection. The first method focused on secondary data, i.e.: a regional knowledge assessment based on existing scientific literature, online retrieval of national statistics and digitalized remote sensing maps, and to a limited degree, expert opinions. The second method focused on primary data collection, i.e.: stakeholder consultations based on a series of national workshops and focus group discussions. Some of the outcome from the national and focus group discussions were included to strengthen views and observations presented in Chapter 4 and 5.

All data were collated, reviewed and synthesized from March to August 2008.

1.3 Structure of the report

This introduction chapter explains the rationale for this regional assessment and the importance of carrying it out. The second chapter reviews some of the key coastal and marine systems within the region and the services rendered by/from the ecosystems to the environment and people. The chapter also examines the poverty scenario within the region, and briefly highlights poverty in the coastal zones.

Chapter 3 discusses in depth the four key drivers that are rapidly causing the loss of ecosystem services in the region, their impacts on coastal users and poverty and trade-offs related to ecosystem services as a result of this key drivers. Chapter 4 concentrates on highlighting the linkages between ecosystem services and poverty through a number of case studies from the region. It further explores the existing regional knowledge, the existing gaps and the existing policy options concerning ecosystem services. The chapter wraps up by presenting a synthesis of all of this key information in a 'regional ES-poverty linkage' table. The final chapter of this assessment illustrates prioritized recommendations for regional research and capacity building.

2.1 Coastal and Marine Ecosystems in the Region

The SEA region is encompassed by two major Large Marine Ecosystems – the South China Sea and the Sulu-Celebes (Sulawesi) Sea. The eight Southeast Asian nations surrounding the seas - Brunei Darussalam, Cambodia, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam are all at different stages of development, but all are going through rapid industrialization (Figure 1). The region now is often referred to as an "emerging" economy as opposed to a "developing" economy. The region exhibits extraordinary levels of diversity in terms of habitats, marine and coastal species, cultural diversity of coastal inhabitants and resource users, and the threats to ecosystems and services that the region's coastal seas provide.

Figure 1: Southeast Asia nations surrounding South China Sea, Sulu Sea and Celebes Sea; Source: World Atlas, encarta.msn.com

2.1.1 Coastal systems

The SEA region has some of the world's most diverse coastal systems, including mangroves forests, coral reefs, seagrass beds, algal beds, estuaries, lagoons, sandy beaches, mudflats, shallow coastal, deep of shore seas, to name a few. The economic exploitation of coastal and marine systems is the major source of income for approximately 500 million people, indicating the importance and vitality of the systems' services towards the well-being of coastal communities.

These ecosystems are most commonly utilized and/or exploited for (1) fishing (capture of wild resources, aquaculture and associated post-harvest processing); (2) coastal agriculture; (3) mining of sea minerals; (4) land reclamation; (5) coastal development/urbanization; (6) tourism and recreation; (7) harbor facilities and shipping; and (8) defense.

By area, the Southeast Asia region accounts for about 30 percent of the global area of coral reefs and 31 percent of the global extent of mangroves (Table 1). Regionally, the largest area of coral reefs are found within Indonesia (figure 2), some 60 percent of the total 85310 km² found in Southeast Asia region. Philippines still has some 30 percent of the total regional extent to date. Globally, Indonesia is covered by the largest (18 percent) and the Philippines the third largest (almost 9 percent) of the total global coverage of shallow coral reefs.

Southeast Asia region also accounts for the most diverse coral reef species. The top three countries which account for the most diverse coral species globally are within the Southeast Asia region - the Philippines, Indonesia and Malaysia, all accounting between 500 and 600 species of coral (see estimates provided by Spalding et al., 2001). In addition, Southeast Asia region also accounts for the most diverse reef fish species found in the coral reef areas (Table 2). In East Malaysia, the state of Sabah accounts for 25 percent of the total national fishery catch (Asian Development Bank, 1991 cited in Yusoff, Shariff and Gopinath, 2006). This illustrates that coral reef services continue to provide economic opportunities to coastal communities in the region.

The largest extent of mangroves (Figure 3) can be found in Indonesia, some 62 percent of the total 46971 km² estimate mangrove coverage in the Southeast Asia region. Other Southeast Asia countries with significant extent of mangroves are Malaysia and Myanmar, each accounting for about 12 and 11 percent respectively of the total regional mangrove coverage. The economic potential of mangrove forests largely stems from their direct use, but the indirect use of mangrove supported resources is also of considerable importance to communities. The uses are based on (1) forest based products; and (2) marine and non-marine products which directly or indirectly contribute to the livelihood of communities living around the mangrove forests. A case study of the Sarawak Mangroves Forest Reserve in East Malaysia valued mangroves through their economic support to the marine fisheries sector at US$21.1 million p.a., which may provide up to 3000 jobs, timber products worth US$123,217 p.a., and a tourist industry worth US$3.7 million p.a (Bennett and Reynolds, 1993) to the livelihood of the community living around the reserve.

Table 1: Global importance of selected coastal systems by country in the Southeast Asia region

	Estimated coral reef area in 2001 (km²)*	% of world total	Estimated mangrove area in 2005 (km²)**	% of world total
Brunei	210	0.07	184	0.12
Cambodia	<50	<0.02	692	0.45
Indonesia	51020	17.95	29,000	19.04
Lao PDR	n.a.	n.a.	n.a.	n.a.
Malaysia	3600	1.27	5650	3.71
Myanmar	1870	0.66	5070	3.33
Philippines	25060	8.81	2400	1.58
Singapore	<100	<0.04	<5	<0.01
Thailand	2130	0.75	2400	1.58
Vietnam	1270	0.45	1570	1.03

Global Coral Reef area: 284,300 km² (Spalding et al., 2001); Global Mangrove area: 152,310 km² / 15.2 million ha (FAO, 2007); Note: n.a. - not applicable

Malaysia and Indonesia account for the highest extent of seagrass coverage (Figure 4) in the region. In Malaysia, out of its some 78 seagrass beds scattered throughout its coasts (Japar, Muta and Aziz, 2006), the most developed and diverse communities are found in the west and south-eastern coasts of Sabah and north-west of Sarawak, areas where urbanization is still minimal.

In Vietnam, the largest seagrass bed is in Phu Quoc. Here, the seagrass ecosystem supports as many as 91 fish species and 106 species of zoobenthos. The live fish food trade, in which high valued fish species are harvested from economically valuable seagrass species in that area, is known to provide a viable income for the local people (Tien et. al., 2006). In another area, called the Thuy Trieu lagoon of Khanh Hoa province, the tiger prawns' seed productivity is dependent on the presence of near-shore seagrass nursery grounds (Dai, 2002).

Table 2: Diversity of coral reefs fish species in the Southeast Asia region

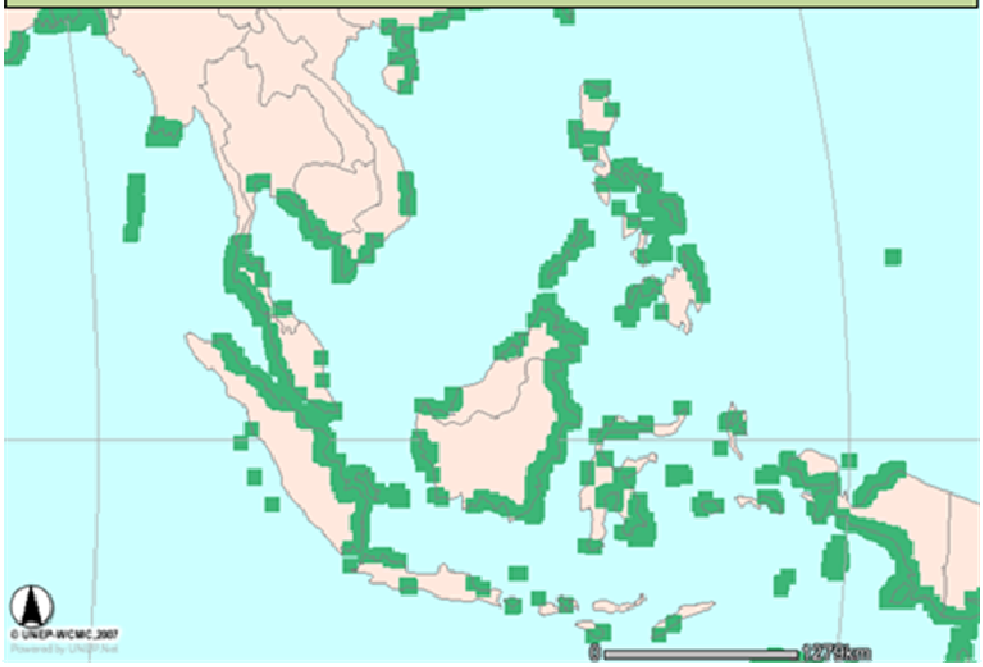
	Marine Fish Species Richness	Hard Coral Species Richness
South East Asia	2500	400-500
Great Barrier Reef	1500	395
Caribbean	500-600	100-200

Source: Vo Sy Tuan, 2007

Figure 2: Coral reef distribution in the SEA region

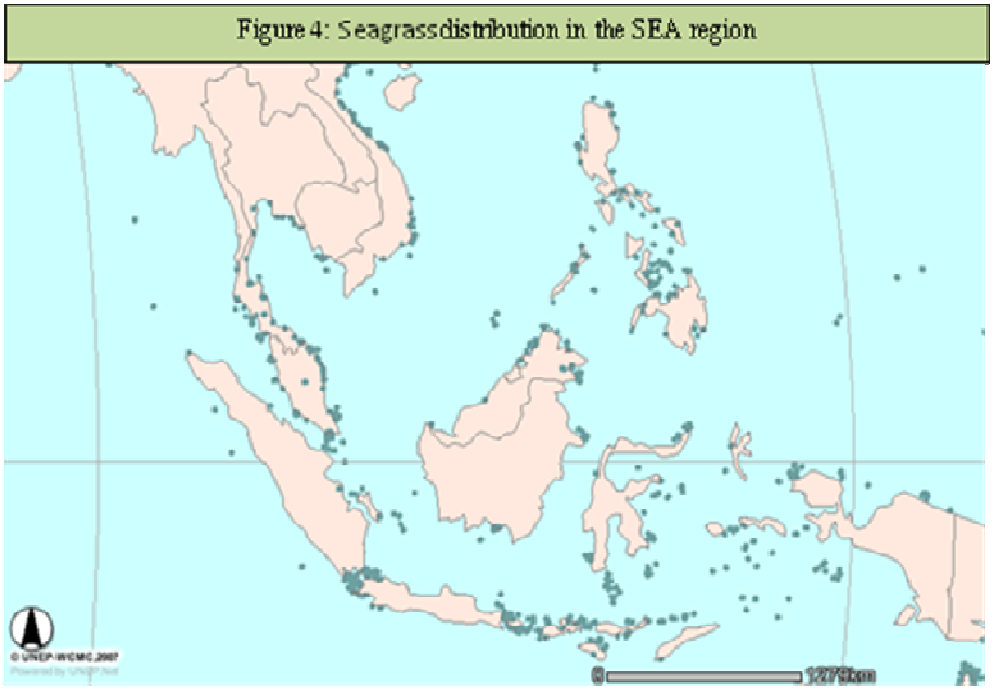
Source: UNEP-WCMC 2007

Figure 3: Mangrove distribution in the SEA region



Source: UNEP-WCMC 2007

Figure 4: Seagrassdistribution in the SEA region



Source: UNEP-WCMC 2007

2.1.2 Marine fisheries systems

The adoption of modern fishing technologies in the 1960s and 1970s gave rise to the current dualistic character of the fishery sector in the region. The traditional fishery sector is typically small-scale, using vessels of less than 40 Gross Registered Tons (GRT) with traditional fishing gear and operates twelve nautical miles from shore. The commercial sector uses larger vessels (greater than 40 GRT) that

operate further offshore, with commercial gear such as trawls and purse seines. The proclamation of the 200 nautical mile Exclusive Economic Zone (EEZ) in the early 1980s extended the fishery jurisdiction and expanded the resource base for most SEA nations.

2.1.2.1 South China Sea

The South China Sea, which lies within the Indo-West Pacific marine biogeographic region has long been recognized as the global center of marine shallow-water, tropical biodiversity. Habitats in the South China Sea include mangrove forests, seagrass beds, coral reefs and soft-bottom communities. The 50-meter depth contour largely follows the coast, with the widest shelves occurring along the eastern edge. The South China Sea is a biologically diverse marine ecosystem. It is considered a Class II, moderately high productivity (150-300 gC/m^2-yr) ecosystem based on SeaWiFS global primary productivity estimates (UNEP, 2005a). High productivity levels are found in gulfs, along the coast, and in reef and seagrass areas, common in the Philippines portion of the ecosystem.

2.1.2.2 Sulu-Celebes (Sulawesi) Sea

The Sulu-Celebes (Sulawesi) Sea is composed of two large seas (Sulu and Celebes) separated by the Sulu Archipelago; and several smaller seas—the Sibuyan, Visayan and Camotes Seas in the northeast and the Bohol Sea further south between Bohol and Mindanao. These 'marginal seas' are mostly enclosed by island land-masses. There are more than 300 watersheds. Many of the coastlines were originally fringed by mangrove forests, seagrass beds, and coral reefs. The Sulu-Celebes Sea, with its terrestrial, coastal and marine ecosystems, lies within the global center of tropical biodiversity, being located near the junction of three major biogeographic zones. With the neighboring Indonesian Seas, the Sulu-Celebes Sea supports very high levels of diversity, exemplified by more than 500 species of reef-building corals and 2500 species of marine fishes (UNEP, 2005b). In the Philippines, through the 1970s to 1980s, reef fisheries contributed from 15 to 30 percent of the total national municipal fisheries production (Carpenter and Alcala 1977). More than one million small scale fishers are estimated to depend directly on reef fisheries for their livelihoods.

2.2 Ecosystem Services (ES)

There are four general types of ES: regulating, provisioning, cultural and supporting services (Millennium Ecosystem Assessment, 2005). These types are not descriptive of the ecosystems or the specific resources themselves; rather, they describe specific contexts of human-environment interactions. In short, ES are the benefits people obtain from ecosystems. These include regulating services such as flood and disease control; provisioning services such as food and water; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. A summary of the important coastal and marine ES in the Southeast Asia region is given in Table 3.

Table 3: Coastal and marine ES in Southeast Asia region

Type	Ecosystem Services (ES)
REGULATING	• protection of coastal areas and agricultural land from waves, storms and flood • water supply • erosion control • climate regulation • pest and disease control • waste processing • larval productivity and dispersal
PROVISIONING	• subsistence and commercial fisheries • aquaculture ground • building material such as timber and pulp/chipwood from commercial forestry • subsistence and commercial extraction of fruits, honey, leaves and wood by households • propagules for reforestation programs • off-shore oil
CULTURAL	• recreation and tourism • coastal and marine protected areas (MPAs)
SUPPORTING	• sediment and nutrient cycling • feeding grounds for dugong, green turtles and migratory birds • habitat and nursery grounds for fish, shrimps, starfish, sea cucumbers, bivalves, gastropods and seaweeds • habitat for ornamental species

As human populations grow, so do the resource demands imposed on ecosystems and the impacts of our global footprint. Many people have been plagued with the misconception that these ecosystem services are free, invulnerable and infinitely available. However, the impacts of anthropogenic use and abuse are becoming ever more apparent – air and water quality are increasingly compromised, oceans are being over-fished, pests and diseases are extending beyond their historical boundaries, and deforestation is eliminating flood control around human settlements.

Ecosystem services are little understood and too sophisticated for us to reproduce even with the most advanced technology, yet the important roles of these natural services are not being recognized adequately in economic markets, government policies or land management practices. As a result, ecosystems and the services they provide are in decline. A review of links between ecosystem services and poverty reduction, supported by case studies, appears in Chapter 4.

2.3 Population

2.3.1 Population and growth

Based on the 2000 Population data (Table 4), SEA holds 8.6 percent of the total world population. The South China Sea zone alone accounts for approximately 350 million (UNEP, 2005a) people. Future scenarios suggest an overall human population increase of approximately 2 percent per year in this area (UNEP, 2005a). The South China Sea zone is extremely heterogeneous and includes some of

the poorest countries of the world (Cambodia, Laos, Myanmar, and Vietnam) alongside extremely wealthy countries like Singapore and Brunei. Areas surrounding the sea span the full gamut of economic activities, from subsistence agriculture and artisanal fisheries to light and heavy manufacturing and high technology industries. Experts predict a continuous process of rapid urbanization, and increased reliance on extractive industries (mining, plantation agriculture, forestry and industrial fishing), although there will be considerable variation in sectoral changes among the nations (Warr, 2006). There is already widespread overexploitation and use of inappropriate technologies, raising serious concerns as to even the medium-term sustainability of the production systems.

The estimated total population surrounding the Sulu-Celebes sea and its catchments is 33 million, of which about 75 percent are in the Philippines (25 million), 21 percent in Indonesia (7 million in East Kalimantan and North Sulawesi) and 4 percent are in Sabah of East Malaysia (< 2 million) (UNEP, 2005b). The population is distributed in the larger urban settlements (with half the Philippines population residing in urban areas), and throughout hundreds of villages spread along the coast, across the lowlands and into the highlands (UNEP, 2005b). Populations are increasing at between 2 to 3 percent annually around this area. The Sulu-Celebes sea area supports a broad range of economic activities, from subsistence agriculture and artisanal fisheries to high technology industries. Subsistence farming and fishing are the major activities of large numbers of people outside of the main urban centers. Other economic activities in the region are oil and gas production from offshore areas as well as tourism, which increases every year and contributes both to the local and to the national economy.

Table 4: Population Growth and Human Settlement in the Low Elevation Coastal Zones of SEA Region

	Population		% Growth	Population in LECZ		% Growth	Total area km²(1995)		Total area km² of LECZ (1995)	
	1990	2000		1990	2000		Urban	Rural	Urban	Rural
Brunei	256,996	328,298	27.7	24,002	31,103	29.6	1058	4843	256	65
Cambodia	9,615,676	13,081,708	36.0	2,553,100	3,122,815	22.3	641	178864	137	13171
Indonesia	182,453,128	212,067,840	16.2	36,087,288	41,609,754	15.3	30958	1867719	8176	168924
Lao PDR	4,132,336	5,278,486	27.7	0	0	0	1058	229172	0	0
Malaysia	17,804,964	22,172,354	24.5	4,360,302	5,211,882	19.5	13455	316490	3775	16746
Myanmar	40,516,987	47,748,611	17.8	10,479,188	12,309,322	17.5	4483	664827	1087	47516
Philippines	60,763,828	75,289,646	23.9	11,093,369	13,329,191	20.2	8201	287208	1872	20807
Singapore	3,016,374	4,018,109	33.2	452,131	602,281	33.2	512	85	62	45
Thailand	54,576,668	62,610,368	14.7	13,349,389	16,478,448	23.4	26438	490485	9207	26569
Vietnam	66,073,600	78,136,408	18.3	36,964,342	43,050,593	16.5	5840	322694	3877	62506

Source of data: http://sedac.ciesin.columbia.edu/gpw/

Land area in world (2000 est.): 130, 677, 398km²; World Population (2000 est.): 6, 056,471,000; World Population in LECZ: 633,957,349

2.3.2 Human settlements in the Low Elevation Coastal Zone (LECZ)

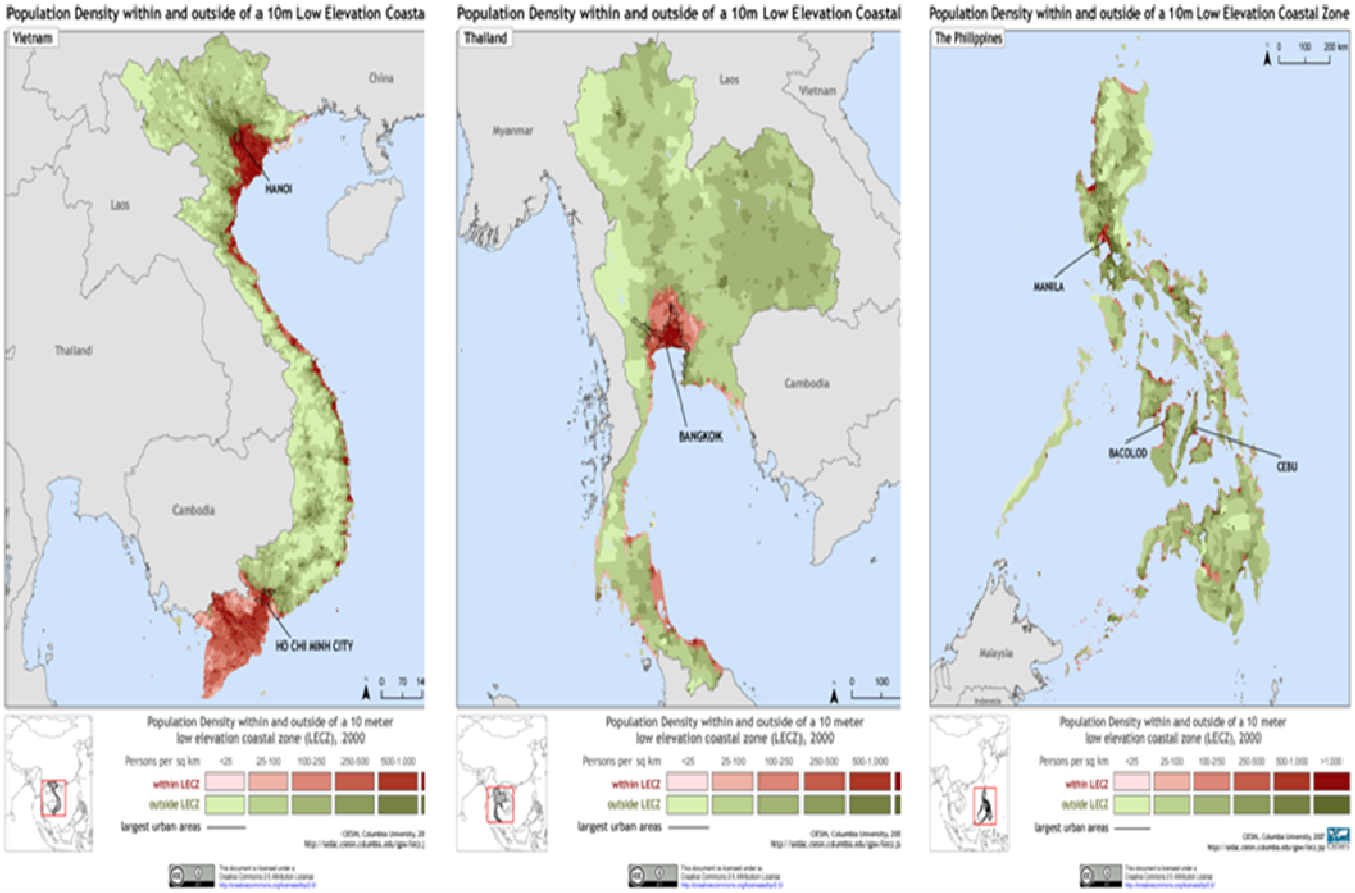
Regionally, the LECZ zone covers almost 9 percent of the Southeast Asian's land area but contains 26 percent of the region's population and almost 36 percent of the region's urban population (refer to Table 4). As with all other regions in the world, coastal systems in SEA region are more densely populated – in both urban and rural areas – than any other zones defined for the Millennium Ecosystems Assessment, except for urban systems themselves (Millennium Ecosystem Assessment, 2005, see pg. 795–825.).

Vietnam accounts for the highest distribution of population (32 percent) in its LECZ area (Figure 5). In Indonesia, 31 percent of the coastal population resides within the LECZ area, with a high

concentration of coastal population on the Western part of Indonesia which is surrounded by the Java Sea. Approximately 12 percent of Thailand's population is concentrated in the nation's LECZ. As shown in Figure 5, it is obvious that the coastal population in Thailand is highly concentrated in the Southeastern part of the country, an area encompassed by the South China Sea. Approximately 10 percent of the population of the Philippines resides within the LECZ area.

Communities living in these low elevation zones are at constant risk from sea-level rise, stronger storms and other seaward hazards induced by climate change (McGranahan, Balk and Anderson, 2007).

Figure 5



2.4 Poverty

Over the last three decades, most countries in the SEA region achieved reductions in absolute poverty incidence, but these reductions varied in magnitude between countries and over time. Despite the impressive long time economic growth in the Southeast Asia region, the rate of poverty reduction seems to be slowing down in many countries (Warr, 2006). This is due to growing income inequality (Warr, 2006), economic vulnerability to external shocks and persistent poverty in certain geographical location of the countries in the region.

For the purpose of this regional assessment, Brunei and Singapore are not included in the poverty trend assessment as both nations are high income countries within the SEA region. Singapore, a small country in terms of area and population, is the fastest growing nation in the SEA region in terms of economic, industrialization and modernization. The per capita income of Singaporeans in 2007 was US$50,000. Brunei shares similar demographic characteristic to Singapore. Brunei builds its economic from agriculture and oil export. In 2007, Brunei's per-capita income was US$27,000. Clearly, being relatively small countries, with burgeoning industrial and service based economies, the relatively small extent of existing ecosystems and their services have minimum impact on the income and poverty of their population. Malaysia is included in this Regional Assessment because despite being a higher

middle income nation, the poverty disparity between West Malaysia and East Malaysia is high. In addition, East Malaysians are known for their relatively high reliance on marine and coastal ecosystems.

2.4.1 Poverty trend

Recent estimates and trends of the national and international poverty lines in the region by countries are listed in Table 5. Based on the national data, rural poverty rates tend to be higher than urban poverty rates.

Table 5: Per capita poverty estimates by country in the Southeast Asia region for selected years

Country	National Poverty Rates (%)				International Poverty Measures				
						$1-a-day		$2-a-day	
	Year	National	Urban	Rural	Year	HCR (%)	Magnitude ('000)	HCR (%)	Magnitude ('000)
Cambodia	1999	35.9	18.2	40.1	1997	34.1	3966.9	77.7	9045.4
Indonesia	2002	18.2	14.5	21.1	2002	7.5	15902	52.4	11095.4
Lao PDR	1997	38.6	26.9	41	1997	39	1882.7	81.7	3945.6
Malaysia	1999	7.5	3.4	12.4	1997	0.2	36.8	9.3	2004.5
Myanmar	1997	22.9	23.9	22.4	n.a.	n.a.	n.a.	n.a.	n.a.
Philippines	2000	34	20.4	47.4	2000	15.5	12136.3	47.5	37224.3
Thailand	2002	9.8	4	12.6	2000	1.9	1204.5	32.5	20264.5
Vietnam	2002	28.9	6.6	35.6	2002	13.1	10509.4	58.5	47058.1

Note: n.a. - data not available; HCR - Headcount Ratio

Sources: National Poverty Rates - Asian Development Bank, Regional Technical Assistance 5917; International Poverty measures - Worldbank, PovcalNet Database, downloaded from http://iresearch.worldbank.org/PovcalNet/jsp/index.jsp

Across countries, extreme poverty is a significant problem in Cambodia and Lao PDR, afflicting more than a fifth of these countries' populations. While a narrow focus on $1-a-day poverty would lead one to conclude that the problem of poverty was not significant in Indonesia, a look at the incidence rate of $2-a-day poverty (Table 5) will convey the fact that the battle for poverty eradication in Indonesia is far from coming to a close.

In the Philippines, the highest incidence of poverty (62 percent) is among the agriculture, fishing and forestry sectors (ADB, 2007). Comparing the incidence of poverty between coastal and non-coastal municipalities showed that for 804 coastal municipalities/cities, the small-area estimate of poverty incidence was 0.49 compared to 0.42 for the non coastal areas, which supports the observation that residents in coastal villages tend to be poorer (World Bank, 2005). A study by Israel (2004) showed that households headed by fishers had significantly higher poverty incidence (61.9 percent) than other households in general. In the Bohol Marine Triangle, seaweed farmers have been reported to earn about 40 percent more than fishers while gleaners earn even less than one third of fisherss fishing income (Samonte-Tan, White, Tercero, Diviva, Tabara, & Caballes, 2007). In contrast tourism operators earn almost four times more than a fisher's income. This highlights the generally deprived conditions of most people involved in the fisheries sector.

In Vietnam, the remarkable decline in the incidence of poverty (based on national poverty data) from 58.2 percent in 1992-93 to 37.4 percent in 1997-98 is one of the sharpest of any developing country on record. Poverty has dropped further since, to 29 percent in 2002, but income data by province and urban authority demonstrate that income inequality has risen significantly from 1995 (UNDP, 2001). The degree of poverty in the Northern Mountains is the highest. Here, most households rely on farming for livelihood, while those who diversify into off-farm employment do slightly better. In terms of poverty density, most of the countries' poor are concentrated along the coastal areas and in urban centres (Figure 6).

In Malaysia, poverty reduction in the 1970's and early 1980s had already led to the virtual eradication of poverty by the late 1980s. The major factor for rural poverty reduction in Malaysia was contributed by the growth in smallholder agriculture through the 1970s and 1980s (IFAD, 2002). However, in East Malaysia, which is populated by the indigenous communities of the nation remains as the country's most impoverished groups, despite the abundance of natural resource wealth (Leete, 2007). In the state of Sarawak, poverty rates are relatively high, with 7.5 percent of households living below the national poverty line. Indigenous communities face not merely disparities in income and wealth, but also challenges in accessing health and education. Sabah remains the poorest state in Malaysia, with more than a quarter (24 percent) of all households is currently living below the national poverty line income. In this state, the progress on poverty reduction and equity has been adversely affected by exceptionally high population growth rates. The state of Sabah has the highest population growth rate in Malaysia, with population doubling from 5.6 percent in early 1960s' to 11.5 percent in 2005. The relatively high fertility of the indigenous communities has been augmented by very high levels of international labor migration, both legal and illegal, from neighboring Indonesia and the Philippines (Leete, 2007).

The poverty gap index (PGI) measures how poor the poor are, and the squared poverty gap index (SPG) measures the severity of poverty by giving more weight to the poorest of the poor (see Table 6). In general, extreme poverty is less of a problem in Southeast Asia when viewed in terms of incidence, but, given large populations in a number of countries in the region, the absolute number of extremely poor can be large. Thus, while Indonesia and Vietnam, especially, have made significant inroads in reducing extreme poverty, the number of poor in these countries and in the Philippines – around 16 million, 10 million and 12 million, respectively – would easily outnumber the entire population of smaller countries with higher rates of poverty.

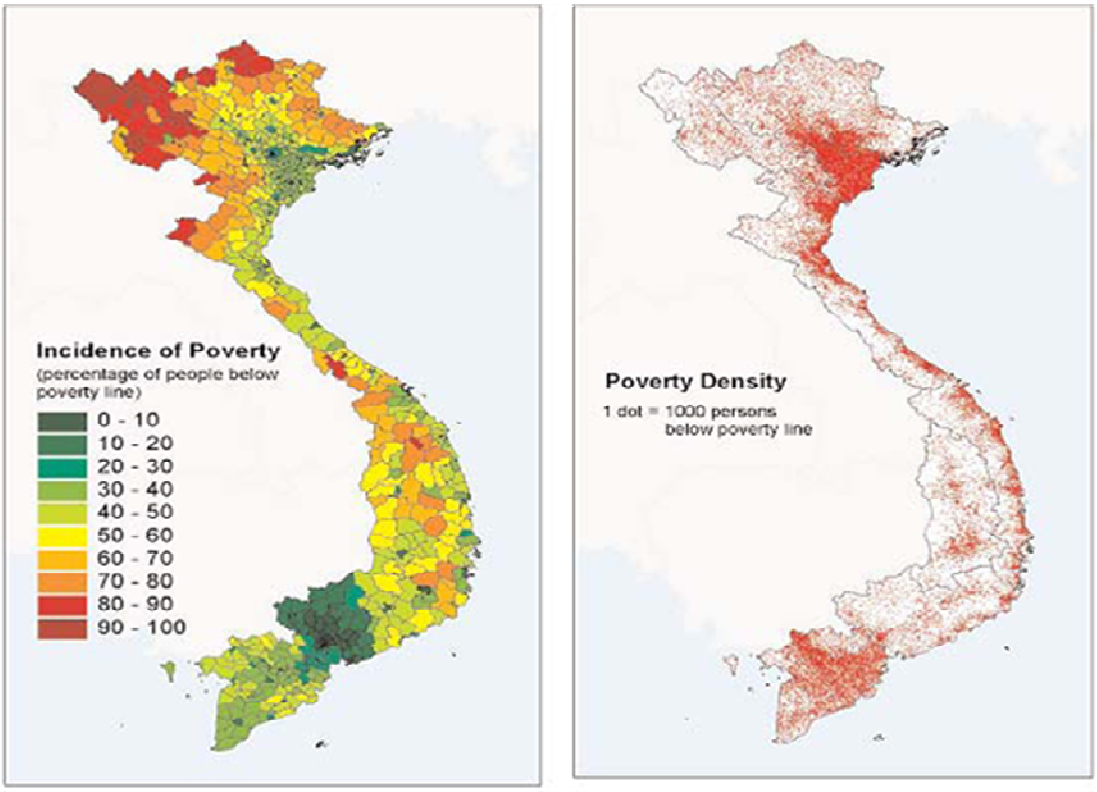
Table 6: Estimated rates of poverty of the poor using the poverty gap index (PGI) and the squared poverty gap index (SPG) for selected countries in the Southeast Asia region for the most reliable data in recent years

Country	Year	PGI (%)	SPG (%)
Cambodia	2004	27.24	13.79
Indonesia	2004	0.46	0.1
Lao PDR	2002	6.26	2.04
Malaysia	1997	0.01	0.00
Myanmar	n.a.	n.a.	n.a.
Philippines	2003	2.49	0.61
Thailand	2002	0.04	0.00
Vietnam	2004	0.04	0.01

Note: n.a. - data not available

Source: World Bank, PovcalNet Database, downloaded from http://iresearch.worldbank.org/PovcalNet/jsp/index.jsp

Figure 6: Incidence of Poverty and
Poverty Density (concentration of the poor) in Vietnam



Source: Vietnam Development Report 2004, pg 12.

Chapter 3: KEY ISSUES AND DRIVERS OF CHANGE TO ES

Coastal and marine ecosystems are among the most productive yet highly threatened systems in the world. While these ecosystems continue to provide critical services related to the well-being of over two billion people worldwide, they are also undergoing drastic changes. Among these are the conversion of mangrove areas, increasing exploitation from rising numbers of small-scale fishers, and damage to the coral reefs, to name a few. These continuous threats to coastal and marine ecosystems are posing critical challenges for the maintenance of ecosystem services and poverty alleviation. As emphasized in the Millennium Ecosystem Assessment (2005), the loss of services derived from ecosystems is a significant barrier to reducing poverty, hunger and disease. This Regional Assessment highlights four critical issues leading/affecting to the deteriorating ecosystem services within Southeast Asia region: (1) habitat loss and degradation, (2) destructive and overfished fisheries, (3) pollution and (4) climate change. Each of these issues will be discussed below.

3.1 Habitat Loss and Degradation

3.1.1 Background

The SEA region lies within the global centre of biodiversity for marine species. The region supports some of the world's most diverse seagrass beds and mangrove forests, as well as 500 species of reef-building corals. These marine ecosystems have been severely degraded in most areas and are increasingly threatened by human activities ranging from coastal development and destructive fishing practices to overexploitation of resources, marine pollution, runoff from inland deforestation and farming, mining and oil exploration. (Burke et al., 2002; UNEP 2005a,b)

Extensive cutting for timber, conversion for aquaculture, other forms of coastal development and sedimentation have caused major fragmentation and reduction in the area of these habitats. Only one-third of the original mangrove forests remain, while seagrass beds have been reduced or degraded by 20 to 50 percent through increased sediments, nutrients and destructive fishing. Human activities now

threaten 88 percent of Southeast Asia's coral reefs, jeopardizing their biological and economic value to society (Burke et al, 2002; PEMSEA 2003). The sea floor is being stripped of their flora and fauna by bottom trawling operations, and marine pollution from coastal cities has also become a significant problem for marine ecosystems and coastal fisheries.

Many demersal fish stocks in the region have been depleted due to the degradation of their habitats, such as coral reefs, mangroves, and sea grass. Coral reef systems are vulnerable to siltation, contamination by pollutants, destructive fish-harvesting practices, and overexploitation, all of which have negative effects on reef productivity (Burke et al, 2002; PEMSEA 2003). Mangrove devastation, arising from indiscriminate extraction and large-scale conversion to other uses, has reduced the capacity of mangrove forests to provide nutrient-rich nursery areas for aquatic species and to protect communities from floods and typhoons. The rapid expansion and intensification of aquaculture have resulted in damage to natural habitats and pollution.

3.1.2 ES affected by habitat loss and degradation

Loss and degradation of marine ecosystems has had, and continues to have enormous socio-economic implications. The present impacts of habitat loss and degradation range from slight to severe. The impacts include:

- Reduced capacity to meet basic human needs (food, fuel) for local populations;
- Changes in employment opportunities for local populations and associated changes in social structures;
- Loss or reduction of existing income and foreign exchange from fisheries, tourism, and other uses;
- Loss of future opportunity for investment income and foreign exchange, and increased risks to capital investment;
- Human conflicts, national and international;
- Injury and death to fishermen using destructive fishing methods;
- Costs of controlling invasive species;
- Costs of restoration of modified ecosystems;
- Inter-generational inequity.

There are particularly serious economic issues in fishing communities, where local fishermen are unable to catch sufficient fish for sustenance. Economic conflicts also occur between developers and local users, resulting from loss of mangrove habitats, loss of charcoal production, costs of rehabilitation, and failures in aquaculture. Other issues that arise from habitat loss relate to health and (loss of traditional medicines, pharmaceuticals, potential increases in mosquito-borne diseases) education. Other social and community impacts include relocation of villages and conflicts among different user groups (e.g. among shallow and deep water fisheries). Progress in managing human use of habitats is not expected to be sufficient to fully mitigate the damaging effects of population growth (UNEP 2005a).

3.1.3 Impacts of this habitat loss and degradation on poverty alleviation

Habitat loss and degradation are already severe in the region, and future levels of environmental impact are expected to remain severe, with continuing deterioration over the next 20 years, because population growth and related exploitation of habitats and target species will more than counter ameliorative interventions (UNEP 2005a,b). The socio-economic impacts of habitat loss and degradation are already moderate (health) to severe (economic and other social and community impacts). There are serious economic and health issues in subsistence fishing communities with the highest birth rates, from reductions in animal protein (UNEP 2005a,b). Additional economic impacts have occurred from loss of mangrove habitats and strip mining.

A variety of approaches to ameliorate habitat loss are being developed in the region, including initial attempts at improving the legislative framework, integrated coastal management, and implementation of large internationally funded protected areas and small community-based protected areas. These initiatives have a long way to go (PEMSEA 2003). A considerable amount of expertise now resides in the region and with improved support there are also strong opportunities for future success.

3.1.4 Resulting trend dynamics for ES

Future levels of environmental impact are expected to remain severe, with both some improvement and some deterioration to 2020. Future poverty alleviation scenarios are also for significant deterioration by 2020, with severe economic and other social and community impacts, and both deterioration and improvement in the health situation, which should remain as slight. The changes are occurring rapidly and accelerating.

The population of the region is expected to increase at approximately 2.5 percent per year, with a doubling by 2035. There is expected to be increasing urbanization, industrialization and reliance on extractive industries; mining, plantation agriculture and industrial fishing. Total pressures are likely to increase moderately over the next 20 years, driven by continued population growth, causing significant deterioration in the environment and socio-economy and poverty. Widespread overexploitation and use of inappropriate technologies raises serious concerns as to even the medium-term sustainability of the production systems, with additional limits to development likely to result from complex linkages between freshwater shortage, habitat loss, fisheries and global change (UNEP2005a,b).

Strong linkages exist between pollution (suspended solids) and habitat loss, as well as between habitat loss and unsustainable exploitation of fish and other living resources (particularly overexploitaiton and destructive fishing practices), via benthic trawling and blast and poison fishing (with strong transboundary links through the live reef fish export trade to East Asia). Modification of coastal habitats is as a result of suspended solids, use of fertilizers and other chemicals, land reclamation, industrial waste, and oil and gas exploration. Root causes of these issues include poor governance (adequate policy but inadequate implementation/management, resources and capacity to execute the law); knowledge (lack of education/awareness, conservation ethics and perceptions); technology developments; market demand; population growth and poverty; and natural variations and climate change (PEMSEA 2003).

3.1.5 Resulting trade-offs in ES

As an example, mangroves cover 4 million ha of the coastal areas surrounding the South China Sea, representing 28% of the world's mangrove forest, and have enormous economic (and environmental) value (UNEP 2004). Products and ecological services provided by these systems are estimated to be worth about 16 billion USD per year (Low et al.1996, Naess 1999, UNEP 1999). Further, the estimated value of seagrass and coastal swamp areas in the South China Sea region is 191 billion USD per year (UNEP 1999). The original area of mangroves has decreased by 70% during the last 70 years. This is largely due to conversion for shrimp hatcheries and mariculture. With a continuation of the current trend all mangroves will have been lost by the year 2030 (UNEP 1999). Many of the shrimp farms have been abandoned, because the operators found them biologically and economically unsustainable due to the high concentrations of chemicals and the destruction of the mangrove habitat.

Uncontrolled land clearing, logging and development in catchments have led to the siltation of rivers, waterways and coastal areas. The impact of siltation on coral reefs and seagrasses is often devastating (Burke et al 2002).

3.1.6 State of knowledge and knowledge gaps

A great deal is known throughout the region about the environmental impacts of habitat loss and degradation. Very little is known about the relationship of habitat loss and degradation and poverty except for mostly anecdotal information. There is a real need to quantitatively characterize the trends of habitat loss and degradation and its impact on poverty.

3.1.7 Policy options related to habitat loss and degradation

Policy options for this set of issues include the development or expansion of:

- Bio-physical (biodiversity) and socio-economic research focused on improving management;
- Functional, integrated networks of marine protected areas with strong co-management focus;
- Integrated coastal management;
- Sustainable livelihoods;
- Information, education and communication networks;
- Institution and capacity-building, including establishment of intergovernmental mechanisms.

3.2 Destructive and Overfished Fisheries

3.2.1 Background

Fish are a critical source of animal protein, healthy lipids, and essential micronutrients. For most people living in developing countries in the region, fish provide more than 20 percent of animal protein consumed, compared to 8 percent in industrialized countries (FAO 2004). Fisheries also provide an important source of livelihoods, food security, and income for hundreds of millions of people, yet fisheries also remain linked with poverty. Globally, at least 20 percent of those employed in fisheries earn less than $1 a day. FAO estimates indicate that the number of full-time fishers worldwide has been growing at an average rate of 2.5 percent per year since 1990—a 400 percent increase since 1950. By comparison, the number of agricultural workers increased by 35 percent during the same period. The number of part-time fishers is increasing more rapidly than full-time fishers as people seek to supplement food and income from other activities.

In South and Southeast Asia, demersal (organisms living on or near the sea bed) fish stocks have been fished down to 5-30 percent of unexploited levels, not only reducing fishers' incomes, but reducing also the contribution of these fisheries to employment, export revenue, and social stability (Silvestre et al 2003). Fishing capacity has increased greatly and is far in excess of the level of activity needed to produce the catches realized and well beyond levels that are sustainable. Unsustainable fishing practices result in direct changes in the structure and composition of aquatic and marine ecosystems, changes that make them less resilient and able to produce food.

Small-scale fishing, which makes up the bulk of employment in the sector in Asia, is much more significant as a source of livelihoods, food security, and income than is often realized. It is estimated that when full-time, part-time, and seasonal men and women fishers are included, there may be more than 40 million small-scale fishers in the region (ADB 2006).
Fish provide more than 20% of animal protein consumed by more than 1.6 billion of the 3.5 billion people in the region (ADB2006). This figure rises to more than 50 percent in such countries as Cambodia and Indonesia. In Southeast Asia, with a population of over 510 million, of whom approximately 35 percent live below the poverty line, average fish consumption is 22 kilograms per capita per year and is even higher in coastal communities (ADB 2006).

The demand for food fish in 2010, calculated at a constant per capita annual consumption rate of 22 kilograms, is estimated to be 18 million to 19 million t (Delgado et al 2003). Marine capture fisheries production is not expected to keep pace with demand, creating concerns for food security in the Asia region. The increasing demand for fish from the expanding population will create more stress on the already depleted coastal and inshore fishery resources in the region. Access to or exclusion from fisheries resources may influence the vulnerability of people to both poverty and food insecurity. Production from coastal capture fisheries in the region will decline over the next 10-20 years unless excess fishing capacity and fishing effort are greatly reduced (Silvestre et al 2003). In the Philippines, for example, an estimate showed that for the demersal and small-scale pelagic fisheries in shallow coastal waters in the mid-1980s, the level of effort was 150 percent to 300 percent of that needed to gain the maximum economic yield, resulting in annual wastage of $450 million (*ref). Prospects for increasing catches are further dimmed by some fishing methods used by small-scale fishers—methods such as using cyanide and explosives, which have had a devastating impact on coastal fisheries and fish habitats, and the health and welfare of fishing households. Although it is men who are more often maimed from explosives and disabled as a result of gear-less diving, it is the women of the households who must shoulder the burden of these men's care and who must increase their own income-earning activities to replace the lost income previously earned by these men.

3.2.2 ES affected by unsustainable exploitation

Socio-economic impacts related to unsustainable exploitation of fish are severe from economic and other social and community aspects, with moderate health effects such as limited malnutrition. There has been widespread loss of income from fisheries collapse and loss of productivity, with concomitant shifts in target species. Fishing 'down the food-chain' is widespread in most countries in the region. Levels of competition for fisheries resources have also been increasing among small-scale fishermen and commercial and foreign fleets.

The key impacts of unsustainable exploitation of fish in the region include:

- Reduced economic returns and loss of employment/livelihood;
- Conflict between user groups for shared resources;
- Loss of food sources (e.g. sources of protein) for human and animal consumption;
- Reduced earnings in one area by destruction of breeding populations and/or juveniles in other areas;
- Loss of protected species;
- Reduced commercial value resulting from tainting;
- Increased risks of disease in commercially valuable stocks;
- Inter-generational equity issues;
- Human health impacts.

3.2.3 Impacts of unsustainable exploitation on poverty alleviation

The present level of environmental impact of unsustainable exploitation of fisheries is severe. Because of increasing coastal population sizes, greater commercialization, declines in resources, lack of effective regulation and poor to non-existent enforcement, there is expected to be a significant environmental deterioration. This will be manifested mostly through overexploitation, increasing by-catch and discards, destructive fishing and changes in diversity, with the potential for decreased viability of stocks, such that the level of environmental impact in 2020 is expected to remain as severe, and get worse than the current situation (Silvestre et al 2003). Poverty and socioeconomic impacts are expected to deteriorate, with severe economic and social and community impacts and moderate health impacts associated with overexploitation of fish by 2020. This prediction may be ameliorated to some degree by improved enforcement of regulations and through successful management interventions by government and NGOs.

The central issue for coastal fisheries in Asia is the depleted state of the resources. In countries with sufficient time series of data (Malaysia, the Philippines and Thailand) from scientific trawl surveys, total biomass has declined to <10 percent of "baseline" estimates (earliest available values, usually prior to the expansion of fishing effort) in some areas, and average biomass had declined to 22 percent of earlier estimates (Stobutzki et al 2006). In the Gulf of Thailand, earlier documented declines from 1965 to the 1980s (e.g., Ritragsa, 1976; Pauly, 1979; Beddington and May, 1982; Chanprasertporn and Lamsa-ard, 1987; and Phasuk, 1987) continued unabated into the 1990s (Kongprom et al., 2003). These drastic declines show no signs of leveling out.

The major contributor to these declines is overfishing, although this is compounded by environmental degradation (Stobutzki et al., 2006). In Vietnam, catch per unit effort only increased 1.8-fold from 1987 to 1999, while the horsepower of the fishing fleet increased at least 3-fold (Son and Thuoc, 2003) indicating a decrease in catch per unit effort when changes in fishing power are accounted for. Exploitation ratios (fishing mortality: total mortality) calculated for 185 stocks across the region show that over 65 percent had exploitation ratios > 0.5 (Silvestre et al 2003). This is above the suggested sustainable range for exploited fish species (0.3–0.5; Gulland, 1988 and Pauly, 1980). In Thailand the exploitation ratios have increased over time, showing a worsening of an already bad situation (Stobutzki et al. 2006).

These drastic declines in coastal resources are linked intimately to 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. In the industrial sector the crew members are also often poor, in some cases with lower incomes than the owners of small-scale vessels (Abu Talib et al., 2003b). Most countries recognize that poverty is an issue in fishing communities and have policy objectives focused on improving the economic conditions of

fishers, particularly in the small-scale sector (Abu Talib et al., 2003a, Barut et al., 2003, Janetkitkosol et al., 2003, Masudur et al., 2003, Purwanto., 2003, Samaranayake, 2003, Son and Thuoc, 2003 and Vivekanandan et al., 2003). However, when resources are depleted and overfishing is prevalent ,poverty is likely to worsen.

Earnings from fisheries are generally lower than those from other sectors. The average GDP per fisher in Vietnam is about US$160 per year, which places fishers among the country's poorest (Son, 2003). In Thailand, the per capita income and total household income of fishers are lower than national averages (Janekitkosol et al., 2003). Within the fisheries sector, artisanal fishers as a group earn the lowest incomes. Likewise, artisanal fishers in Thailand, Malaysia, the Philippines, and Indonesia live below poverty thresholds (Samaranayake, 2003; Jane-kitkosol et al., 2003; Abu Talib et al., 2003; Barut et al., 2003; Purwanto,2003).

To completely understand the causes of poverty among artisanal fishers, one must not confine the analysis to the fisheries sector, but must look beyond it. However, it is still instructive to consider factors within the fisheries sector. The obvious causes of poverty among artisanal fishers include dwindling fishery resources and the highly unequal distribution of total catches in favor of the commercial sector, at least on a per capita basis (Pauly and Chua, 1988). Also, artisanal fishers are mired in poverty because they are likely to have few alternatives to fishing. Other factors are less well-known and may be confined to certain places. Some credit systems may increase the burden on artisanal fishers, and there is a tendency among fishers, to not save, but to increase spending during periods of high catches.

The fishery sector has the potential to contribute to poverty reduction in the region. Capture fisheries have moderate scope for increasing benefits to poor fishers and consumers if fisheries are governed responsibly and equitably. Some indicators now suggest that fishing is no longer the "employment of last resort," and that fishing communities are actively diversifying into the general economy.

Measures to reduce poverty among coastal fishers and fishing communities cannot be divorced from the need to address the downward spiral in coastal fisheries resources. The restoration and improved management of stocks is urgently required to reduce poverty among fishers and sustain the contribution of coastal fisheries to the economies of developing countries. Owing to the technical, personnel and financial constraints faced by many Asian countries, however, the rehabilitation and improved management efforts needed to rebuild fish stocks to more productive levels will depend on catalytic interventions to identify and implement the measures. Sustaining the gains over the long-term will also depend on increasing national capacity in coastal fisheries assessment, rehabilitation, planning, management and policy reform.

3.2.4 Resulting trend dynamics in ES

The result of over-fishing in Southeast Asia is that coastal fish stocks have been severely depleted. Resources have been fished down to 5 -30 percent of their unexploited levels. Such declines have increased poverty among already-poor coastal fishers in developing Asian countries. Over-fishing has also reduced the contribution of coastal fisheries to employment, export revenue, food security and rural social stability in these nations. The trends (resource decline, increasing poverty and impaired contribution to national development) are expected to worsen as coastal populations increase, unless remedial action is undertaken.

The immediate causes of overfishing are expansion of fisheries, including the use of destructive methods; economic (market demand; export pressures for fisheries products, aquarium trade and alien species); demographic (overpopulation, particularly among poor coastal communities; poverty and limited access to alternative livelihoods); knowledge (perpetuation of environmentally damaging traditional practices; lack of awareness of environmental change); and governance (lack of political will; poor governance).

The state of knowledge about coastal fish stocks in the region is certain. Overall, resource analyses illustrate substantive degradation and over-fishing of coastal fish stocks. Stock analyses indicate that catch rates and hence resource biomass have declined to 4 to 44 percent of original ("baseline") biomass levels in the fishery areas. Massive declines in resource biomass have led to substantive

changes in species composition of the coastal fishery resources. It is not clear whether thresholds have been reached.

Fish have become relatively more expensive than other food items; this trend is likely to continue, impacting poor people disproportionately. Per capita consumption of fish for food in the region is expected to increase at 2 percent per year to 2020 (Delgado et al 2003). More and more fish production will need to come from aquaculture to meet this increasing demand. Changes in relative prices will also result in a shift from fish to other sources of protein, particularly chicken and pork.

3.2.5 Resulting trade-offs in ES

The decline of capture fisheries has affected livelihoods, increased vulnerability to poverty, and meant less availability of fish protein per capita. In particular, small-scale fishers have seen their income decline. Decreasing catches have also reduced resource rents from the fisheries and critical foreign exchange earnings from fish exports and fisheries agreements. Overfishing is threatening the nutritional status of many people in the region for whom fish products can constitute 50 percent or more of their essential animal protein and mineral intake (although the rapid growth of aquaculture has offset some losses from the decline in capture fisheries). However, this decline puts additional pressure on agriculture and other land resources to provide food or marketable goods, particularly for those involved in subsistence fishing.

3.2.6 State of knowledge and knowledge gaps

The relative social and economic contribution of the fisheries sector is often hard to assess due to the lack of robust data for small-scale fisheries in most countries. A primary cause of weak governance in small-scale fisheries is the lack of knowledge and information about the sector. Conventional fisheries information systems that have been developed mainly for “northern” fisheries systems are poorly suited for small-scale tropical fisheries sector due to the multi-species nature of the fisheries, large number of fishers, numerous dispersed landing sites, and high proportion of total capture fisheries consumed locally that do not enter commercial market chains (Silvestre et al 2003). Basic demographic and technological information is needed for policy and management, such as number and sex of small-scale fishers and their households, number and variety of boats and gear, demographic and catch information on gleaners, livelihood and occupational structure for men and women, location of operation, and annual catch and sex-disaggregated data on post-harvest fisheries activities, including unpaid labor, employment and enterprise ownership. Expanded collection of sex-disaggregated data for fisheries will enable countries to determine both women’s contributions to the fisheries sector, as well as national and sub-national resources spent to improve women’s employment and enterprise income from fisheries-related activities. Increased availability of sex-disaggregated information will increase the relevance of proposed policies and avoid negative impacts on women’s economic or political status or their access to resources.

Reliable data on small-scale fisheries are more often than not non-existent, inaccurate, unknown, or unable to be released. As long as this situation remains, it is impossible to create a true profile of the sector—its challenges, its current contributions to local, national, and world economies, its potential opportunities, and the costs of the world taking no action (or action too late) to address the current situation of increasing demand, decreasing supply, and fishing overcapacity.

3.2.7 Policy options related to unsustainable exploitation

Interventions to improve fisheries management in the region need to focus urgently on reducing fishing capacity. Fish stocks can be rebuilt to more productive and sustainable levels only if fishing pressure is reduced: maintaining current levels can lead only to further depletion of the resources. The socioeconomic benefits from fisheries will also continue to be dissipated if overfishing continues. Interventions include integrated coastal fisheries management, livelihood approaches, protected areas, co-management, and minimizing by-catch and post-harvest losses.

In the last decade, policies on fisheries development have started shifting towards more sustainable management. The paradigm of capture fisheries management has also changed—from a narrow, predator-target prey basis to one based on accounting for effects on other parts of the ecosystem in which a fishery is embedded (Berkes et al. 2001). Fisheries management now has not only biological

objectives but also institutional, political, and social objectives. This new approach to fisheries management takes into consideration integrated coastal resources management; rights-based management where fishing rights provide exclusive or preferential access to aquatic resources by individuals or groups; and co-management, in which government and resource users share responsibility for managing the resources. These newer approaches have the potential to expand the role and participation of diverse stakeholders, including both women and men, in decisions about fisheries resources management. This is a step in the right direction. However, the capacity to implement such approaches is largely lacking and many of the management actions needed require moving capital and people out of the fishing sector—a move that requires strong political will, a will that at present is largely absent. In spite of these challenges, if fisheries are governed responsibly and equitably, the sector has great potential to contribute to poverty reduction, economic growth, biodiversity conservation, sustainable livelihoods and peace and security.

3.3 Pollution

3.3.1 Background

The health of marine ecosystems in Southeast Asia is in serious decline due mainly to coastal development (PEMSEA 2003; UNEP 2005a,b). Rapid economic development and population growth have caused significant ecological damage in coastal and marine areas, and the already large population in the area is expected to double in the next three decades. Across Asia, only 35 percent of wastewater is treated, and in much of the SEA region, sewage treatment is superficial at best. Raw and/or primary treated sewage is discharged directly into water courses, which affects biodiversity and fisheries and has health impacts on downstream populations. Agricultural pollution is also widespread; leaching of fertilizers and pesticides into watercourses, massive loss of soils following land clearing and forestry and increasing aquaculture activities have resulted in increased levels of nutrients and sedimentation in rivers and coastal systems. Industrial forms of water pollution are concentrated in the major urban centers. SEA is also a major shipping hub, with significant associated levels of.pollution (e.g. from oil spills, waste dumped in ports, and ballast discharge). There are 35 pollution hotspots and 26 sensitive and high-risk areas identified in countries and subregions bordering the South China Sea.

A 2003 report on Sustainable Development Strategy for the Seas of East Asia identified pollution as a major issue in the region (PEMSEA 2003):
• Projected growth in production will also generate increasing industrial and domestic wastes, the major sources of marine pollution in the region.
• The current level of sewage treatment in the region is low. For example, just over 10% of the organic component is removed by sewage treatment in countries bordering the South China Sea. Unless this is drastically improved, the sewage from increased populations in concentrated areas will accelerate eutrophication and threats to public health at transboundary levels.
• Nonpoint sources of pollution, or runoff from such diverse activities as agriculture, mining, timbering and land-clearing, and residential and commercial development are increasing in volume. Evidence indicates that land-based sources are polluting nearshore areas and bays and inlets and may also be affecting the main areas of LMEs.
• International trade is anticipated to triple in the next 20 years and between 80 and 90% of this is expected to move by shipping. About 300 oil spills with over 200 million gallons of oil were spilled in the region since the mid-1960s. Although these numbers were largely in decline during the decade, the projected increase of shipping traffic increases the likelihood of oil spills.

The main contaminant load of the region emanates from land-based activities. This has been found to affect the most productive estuaries, bays and the near-shore areas. These areas are, likewise, threatened by the physical alteration of the marine environment, including destruction of the coastal habitats that are of vital importance to ecosystem health and biodiversity. In addition to localized effects, persistent contaminants originating from the land are transported through great distances by water courses, ocean currents and atmospheric processes, posing risks to human health and living resources on a regional and global scale (PEMSEA 2003).

Eutrophication—the over-enrichment of waters by nutrients—threatens and degrades many coastal ecosystems in the region. The two most acute symptoms of eutrophication are hypoxia (or oxygen depletion) and harmful algal blooms, which among other things can destroy aquatic life in affected areas. It is known that eutrophication diminishes the ability of coastal ecosystems to provide valuable

ecosystem services such as tourism, recreation, the provision of fish and shellfish for local communities, sportfishing, and commercial fisheries. In addition, eutrophication can lead to reductions in local and regional biodiversity (UNEP 2005a,b).

3.3.2 ES affected by pollution

Socio-economic impacts of pollution are related to poverty and are concentrated in the major urban centers. There have been losses in fisheries, economic losses to aquaculture facilities and the shellfish industry through regular advisories of high levels of toxicity and also losses in wildlife and recreational value, and land use conflicts. Health issues include harmful algal blooms and cases of mercury poisoning. There have also been costs associated with clean-ups and coastal restoration. There is a lack of data in the region to fully document the impacts. The key impacts include:

- Increased risks to human health;
- Increased costs of human health protection;
- Loss of water supplies (e.g. potable water);
- Increased costs of water treatment;
- Costs of preventive medicine;
- Costs of medical treatment;
- Costs of clean-up;
- Loss in fisheries;
- Change in fisheries value;
- Costs of reduced fish marketability due to aesthetic perceptions;
- Reduction in options of other uses of freshwater;
- Potential for international conflicts;
- Damage to equipment (e.g. particle impacts);
- Avoidance of amenities and products due to perceptions of effects of contamination;
- Costs of preventative measures;
- Costs of contingency measures.

3.3.3 Impacts of pollution on poverty alleviation

Around 270 million people live in the coastal areas of the region, and this population is expected to double in the next three decades (*ref). The area's rapid economic development and population growth are the cause of significant ecological damage in coastal and marine areas. Socio-economic impacts of pollution in the region are moderate at present. Most impacts are related to poverty and are concentrated in the major urban centers. Lack of education, oppression, lack of appropriate infrastructure—from water-treatment facilities to better roads and communication—all exacerbate the twin problems of poverty and environmental degradation. One cannot ask people to heal the environment, or even just mind it, if they can barely sustain themselves.

Although most of the countries have signed and ratified relevant conventions and treaties, such as the Convention on Biological Diversity, Global Program of Action for the Protection of the Marine Environment from Land-based Activities, and Montreal Declaration on the Protection of the Marine Environment from Land-Based Activities, 2001, many are unable to implement regulations effectively (PEMSEA 1999). There is seldom one ministry or department that coordinates the implementation and enforcement of anti-pollution laws. Further, policy makers generally view pollution mitigation or control projects as irrecoverable and unproductive investments.

3.3.4 Resulting trend dynamics for ES

Increasing urban development and population growth will result in increased levels of marine pollution. To 2020, environmental impacts from pollution are likely to increase, but remain as moderate, primarily because of the predicted increases in forestry and agriculture, and a major increase in population overriding the improvements in infrastructure. (UNEP 2005a,b) The rate of change of marine pollution is accelerating in the region, although impacts on poverty are still moderate at present. Environmental impact of suspended solids is already severe, primarily resulting from deforestation over the past 150 years. (UNEP 2005a,b)

Although much of the damage from pollution has been caused by institutional failures, the pressures of poverty compound the threat. Poverty contributes to increasing stresses to the ecological systems, which in turn exacerbate institutional failures and economic productivity. High population levels and growth rates increase pollution. Rapid urbanization and unequal development in the rural areas fuel in-migration, add stress to existing physical and social infrastructures, and compound the environmental problems.

The three causes of pollution problems – institutional failures, high population growth rates and poverty – pull in different directions, but feed upon one another, and together create conflict between concerns about impacts of pollution, and matters that are specific to the needs and concerns of poor people. There exists cumulative causation, thus poverty reduction strategies need to be accompanied by policies and actions that enhance the quality and productivity of the environment and natural resources and human capital.

The state of knowledge about marine pollution in the region is certain. The environmental impacts and threats from pollution in the region have been well documented.

There is not yet evidence of thresholds having been reached. For pollution, the present level of environmental impact in the region is moderate. (UNEP 2005a,b) However, environmental impact of suspended solids is already severe, primarily resulting from deforestation over the past 150 years. To 2020, environmental impacts from pollution are likely to deteriorate.

3.3.5 Resulting trade-offs in ES

Regulations and laws governing the sources of pollution have not been sufficiently developed or followed up by local and national governments as economic growth and industrial development are more highly valued than protection and management of the marine environment. The overall socio-economic prognosis for the future is for deterioration causing severe impact to the economies. By contrast, there is expected to be an improvement in health issues (becoming slight), and both improvement and deterioration in other social and community aspects (remaining moderate), mostly because of an increase in projects for pollution mitigation and control (e.g. sewage treatment).

3.3.6 State of knowledge and knowledge gaps

The socio-economic impacts of marine pollution on coastal communities in the region are moderately evaluated. There is very limited information on the full impacts on poverty beyond some anecdotal information. The existing information on trends is that pollution impacts on the poor will increase. It is expected that there will be limited government response to this issue even though management interventions exist.

3.3.7 Policy options related to pollution

There is a need to implement and conduct integrated and sustainable management of marine related pollution. This is being done, in part, through the UNDP/GEF/IMO Regional Program for the Prevention and Management of Marine Pollution in the East Asian Seas (PEMSEA).

3.4 Climate Change

3.4.1 Background

The effects of climate change on coastal and marine systems are becoming increasingly apparent, and are predicted to be wide-ranging, and will include changes in habitat quality, availability, and in the distribution and abundance of fished species (Roessig et al, 2004). It is the small-scale fishers, who lack mobility and alternatives and are often the most dependent on specific fisheries, who will suffer disproportionately from such changes. Lowered rainfall in some areas will affect inland fisheries as well as many coastal and estuarine fisheries where rainfall levels and freshwater pulsing is related to fisheries productivity.

Since some ecosystems are highly sensitive, even small changes can have large effects. Minor increases in sea surface temperature can, for example, damage coral reefs, because corals are vulnerable to 'bleaching' (the loss of their symbiotic algae, which can be lethal if sufficiently severe or prolonged) (Brown, 1997). Coral bleaching events have increased in frequency and severity with rising sea surface temperatures (McWilliams et al, 2005) and resulting impacts will exacerbate the impacts of other anthropogenic stressors on reefs, such as pollution and over-fishing, and thereby cause a reduction in corals and fish stocks, jeopardizing fish- and tourism-dependent livelihoods. Reef-building corals face a second climate-change related threat, as oceans are becoming increasingly acidic due to the absorption of atmospheric carbon dioxide. Under more acidic conditions, corals and other calcifying marine organisms (such as shellfish, sea urchins, and starfish) are less able to make their calcium carbonate skeletons and shells (Feely et al, 2004). The combined effects of sea surface temperature rise and oceanic acidification could mean that climate change is likely to have significant negative impacts on tropical reefs by the middle of the 21st Century (Hoegh-Guldberg et al, 2007). The environmental and socioeconomic costs, especially to fisheries communities in developing countries, could be enormous.

Climate change impacts on coastal areas in tropical Asia will potentially be 'severe and in some areas catastrophic'. Heavily populated and intensively used low-lying coastal wetlands (including mangroves), deltas, plains and islands are most at risk from sea-level rise in the form of coastal erosion, habitat loss or 'coastal squeeze', flooding and salt water intrusion (see Nicholls et al, 1999). The large deltaic regions of Bangladesh, Burma, Thailand and Vietnam, and low-lying regions of Indonesia, the Philippines and Malaysia are especially vulnerable.

As for fish production (in temperate Asia), the IPCC states that with global warming the positive effects on saltwater fisheries (for example longer growing seasons and lower winter mortality) 'may be offset by negative factors' such as changes in reproductive patterns and ecosystem relationships. The disappearance of sandy beaches in Southeast Asia as a result of sea-level rise would undermine tourism in this region which currently provides an important source of income.

3.4.2 ES related to climate change

The socio-economic impacts associated with climate change are uncertain but include economic and health effects associated with drought and linkages to habitat loss (clearing and forest fires) and freshwater shortage, particularly overextraction of freshwater and salination of wells. Health effects include potential links to dengue and hemorrhagic fever and respiratory illnesses from haze and forest fires, with some displacement of communities due to fires and floods.

The impacts include:

- Freshwater availability;
- Food security;
- Employment security;
- Changes in productivity of agriculture, fisheries and forestry;
- Changes in resource distribution and political jurisdiction;
- Response costs for extreme events;
- Loss of income and employment;
- Loss of incomes and foreign exchange from fisheries;
- Loss of opportunity for investments (both domestic and foreign);
- Increased costs of human health care.

3.4.3 Impacts of climate change on poverty alleviation

The impacts of climate change and the vulnerability of poor communities to climate change vary greatly, but generally, climate change is superimposed on existing vulnerabilities. Climate change will further reduce access to drinking water; negatively affect the health of poor people, and will pose a real threat to food security in many countries. In some areas where livelihood choices are limited, decreasing crop yields threaten famines, or where loss of landmass in coastal areas is anticipated, migration might be the only solution. With warming, vector borne diseases such as malaria are

predicted to increase. Floods and droughts may also increase the incidence of disease, particularly floods which spread water-borne infections. Climate change is expected to deplete and change the composition of forests, adding to sedimentation in coastal areas. Loss of biodiversity and ecosystems as a result of climate change may impact rural livelihoods and health. The macroeconomic costs of the impacts of climate change are highly uncertain, but very likely have the potential to threaten development in many countries.

Poor people are highly vulnerable to ecosystem degradation. While local economic and social conditions drive poor people into marginal areas and force them to exploit natural resources to support their livelihoods, climate change further erodes the quality of the natural resource base, thereby reinforcing conditions of poverty. In cases where climate change effects on ecosystems may create new opportunities, poor communities are also less likely to derive associated benefits, given reduced capacity to adapt to such changes. Changes in ecosystem composition and provision of goods and services may also have wider economic effects. Essential ecosystem services include breaking down wastes and pollutants, purifying water, and maintaining soil fertility. Climate change will alter the quality and functioning of ecosystems, reducing their capacity to perform their role as important life support systems. This will have important impacts on key economic sectors such as agriculture, water supply, and others.

In the Philippines, “climate change is a very emotional subject because the issue is viewed not only as causing additional economic burdens, but as a critical factor that would determine its survival as a nation”. Many of its people are in coastal areas and at risk from the impacts of extreme climatic events, sea level rise and degradation of marine ecosystems. The effects of climate change on agriculture, forestry and water resources will further encumber a country already reeling from a host of socio-economic and environmental problems.

Low-lying coastal communities will have to deal with sea level rise and the impact of climate change on marine resources. Sea level rise may result in the loss of mangrove habitat, and may lead to salinization and render agriculture areas unproductive. In areas where fish constitute a significant source of protein for poor people, declining and migration of fish stocks due to climate change and associated changes in the marine environment will further need to be considered in their impact on the local food security.

The poor will need to devote more of their already limited resources to coping with adverse climatic conditions. Climate change may thus force drastic changes to livelihood strategies. Where economic diversification is low, income opportunities and hence options for developing alternative livelihoods in response to climatic changes may be limited. In some cases migration, which is an important coping strategy for poor people, might be the only solution, but will potentially cause social disruption.

Adaptation to climate change is a priority for ensuring the long-term effectiveness of investment in poverty eradication and sustainable development. Many examples show that addressing poverty implies also preparing for climate variability and extremes. While climate change is only one of the many factors influencing poverty, immediate action should be taken to adapt to climate change impacts. A strategy to address climate change impacts on the poor is by integrating adaptation measures into sustainable development and poverty reduction strategies. Many adaptation mechanisms will be strengthened by making progress in areas such as good governance, human resources, institutional structures, public finance, and natural resource management. Such progress builds the resilience of countries, communities, and households to all types of shocks, including climate change impacts. Strategies to cope with current climate variability provide a good starting point for addressing adaptation needs in the context of poverty reduction.

3.4.4 Resulting trend dynamics ES

Climate change is likely to bring about gradual changes, such as sea level rise, and shifts of climatic zones due to increased temperatures and changes in precipitation patterns. Also, climate change is very likely to increase the frequency and magnitude of extreme weather events such as droughts, floods, and storms. While there is uncertainty in the projections with regard to the exact magnitude, rate, and regional patterns of climate change, its consequences will change the fate of many generations to come and particularly impact on the poor if no appropriate measures are taken.

Environmental impacts are expected to deteriorate, but remain slight by 2020 (*ref). Increasing per capita releases of CO_2 and the increasing global population will increase local production of greenhouse gases. However, there is considerable uncertainty in fine-scale climate model predictions of changes in temperature and sea level, and also in the capacity for acclimation and adaptation of species and ecosystems. Corresponding socio-economic aspects are also expected to deteriorate, with moderate levels of economic impact and other social and community impacts and slight health impacts by 2020.(*refs)

Climate change is expected to have only slight present environmental and socio-economic impacts. Climate change impacts on coastal ecosystems are likely to be minimal in the short-term, but will increase over time. In some systems, abrupt and potentially non-reversible shifts in ecosystem state may result when 'tipping points' (i.e. critical thresholds) are exceeded (Hoegh-Guldberg et al, 2007).

Climate change will compound existing poverty. Its adverse impacts will be most striking in coastal areas because of their geographical and climatic conditions, their high dependence on natural resources, and their limited capacity to adapt to a changing climate. Within these areas, the poorest, who have the least resources and the least capacity to adapt, tend to be the most vulnerable. Projected changes in the incidence, frequency, intensity, and duration of climate extremes (for example, heat waves, heavy precipitation, and drought), as well as more gradual changes in the average climate, will notably threaten their livelihoods – further increasing inequities between the developing and developed worlds. Climate change is therefore a serious threat to poverty eradication. However, current development strategies tend to overlook climate change risks.

Corresponding socio-economic aspects are also expected to deteriorate, with moderate levels of economic impact and other social and community impacts and slight health impacts by 2020. According to Talaue-McManus (2000 and pers. comm.) there is sufficient evidence of major environmental changes resulting from global climate change in the region. While the socio-economic impacts are yet to be evaluated, their signature on SSTs as well as long term changes in air temperatures and on atmospheric chemistry are unequivocal.

3.4.5 Resulting trade-offs in ES

Uncertain at this time. There have been some economic and health effects associated with drought and linkages to habitat loss (clearing and forest fires) and freshwater shortage, particularly overextraction of freshwater and salination of wells.

3.4.6 State of knowledge and knowledge gaps

The socio-economic impacts of climate change on coastal communities in the region are yet to be fully evaluated. There is very limited information on the full impacts on poverty beyond some anecdotal information. The existing information is too limited to characterize trends.

3.4.7 Policy options for climate change

An approach that uses both mitigation and adaptation is needed. Current commitments to mitigate climate change by limiting the emissions of greenhouse gases (GHGs) will not, even if implemented, stabilize the atmospheric concentrations of these gases. Developing adaptive capacity to minimize the damage to livelihoods from climate change is a necessary strategy to complement climate change mitigation efforts.

Chapter 4: A REGIONAL SUMMARY OF ES-POVERTY LINKAGES

4.1 State of current knowledge

The ubiquitous and abundant supplies of marine and coastal resources in the SEA region have resulted in minimal concern about their conservation and sustainable exploitation. In fact, these resources are continuously threatened by human activities such as overexploitation of living resources, massive land reclamation and development, discharge of harmful industrial and domestic

wastes, and large energy development projects. Threats to the sustainability of these resources in the form of land-based and sea-based pollution are becoming serious and to a certain extent are affecting the well-being of the people.

There is an increasing demand for ecosystem services due to high population growth and economic development in coastal areas (such as aquaculture, tourism, industry). Policy makers, coastal managers and researchers have paid more attention to provisioning and cultural services while the importance of regulating and supporting services remains at a basic level of awareness and academic knowledge. In Vietnam for example, the total area for shrimp aquaculture has increased from 250,000 ha in 2000 to 478,000ha in 2001 and 530,000 ha in 2003. Today, Vietnam probably has the largest total area for shrimp aquaculture in the world. However, the capacity of ecosystem services to respond to such high demand remains low due to general trends toward reduced ecosystem area and productivity caused by anthropogenic and natural factors. This has negatively affected the lives of humans, especially the poor who have fewer opportunities to get access and benefits from ecosystem services.

In general, there is great deal known about ecosystems and ecosystems services in the region; a lesser, but still significant, amount known about poverty in coastal areas; and a limited amount known about the link between ecosystems and poverty in the region (see ***Annex 1: Summary of ES and poverty linkage in SEA region***, page 45). There is a well developed body of knowledge about ecosystems and their services in the region, compiled primarily by research institutions and individuals. The information about these services is usually broken down in each country to the regional and local levels. In a number of cases, the research was done within the scope of a project or a certain geographic area, thus, it is not possible to have a complete picture about all services at the national level. Most of the information about these services remains at the researcher or project level and is thus not easily or readily available to policy makers and resource managers. Poverty studies in coastal areas are primarily at the local government level; however, the data and information are often not up-to-date. General information about the access by the poor to various ecosystem services is available at the case specific level. Although information is available at specific levels, this creates an incomplete national picture.

To understand the relationships between humans and natural ecosystems through the services derived from them, the following case studies from Vietnam[2], East Malaysia and the Philippines[3] can be considered:

Regulating services:
The value of shoreline protection of coral reefs can easily be seen in some marine areas in the central provinces of Vietnam such as Bai Tien and Hon Khoi, Khanh Hoa province. Mangrove forests significantly reduce coastal erosion and may provide protection from tropical cyclones and tidal waves. Mangrove roots, especially where vegetative communities grow densely, help sediment to accumulate more rapidly. Natural hazards, such as typhoons and storm surges, are not uncommon in coastal communities, particularly in the North-Central and Central Coastal regions. Thus, the protection role of mangrove should be increased to ensure the security of local people. Each square meter of seagrass can generate ten liters of dissolved oxygen that contributes to balancing O_2 and CO_2 in the water environment, and assists to mitigate the greenhouse effects due to efficient absorption of the CO_2 in the water.

Provisioning services:
The value for the annual production of goods and services (as cited in Hue et al., 2008) of the coral reefs in Vietnam is estimated at approximately USD 100 million, one square km of coral reef can provide a total of fish an equivalent to USD 10,000, one ha of mangrove reforest supports a marine catch of about 450 kg in the Mekong Delta, seagrass support both commercial fisheries and services value at over USD 20 million per year and the total economic value of lagoon in Vietnam is estimated at more than USD 2000 per ha.

[2] Case studies from Vietnam were cited from 'Hue, N.T., Hien, T.T., Thu, H.T.Y., Dao, P.T.A., and Quan, N.V. 2008. Situational Analysis of Coastal and Marine Ecosystem Services and Poverty Alleviation: Vietnam Country Assessment Report. Centre for Marinelife Conservation and Community Development (MCD) Unpublished Report, Hanoi'

[3] Case studies from the Philippines were cited from 'Siason, I.M., Subade, R.F., Beldia, P.D., and Garces, L.R.. 2008. Situational Analysis of Coastal and Marine Ecosystem Services and Poverty Alleviation: Philippines Country Assessment Report. University of Philippines-Visayas (UPV), Unpublished Report, Iloilo.'

In Banacon Island, Bohol, Philippines, the residents of the 550 households have always depended on the harvest of mangrove wood to meet most construction and domestic fuel needs (Walter 2004). The continuous extraction from mangrove and other coastal forest trees are highly popular with rural coastal communities because it provides them the opportunity to obtain cheaper alternative services than to purchase those commercially supplied by shops or stores.

The establishment of marine protected areas has direct impacts related to the well-being of coral reefs. In the San Salvador, Zambales MPA in the Philippines, live coral cover showed a 10 year increase from 23 percent to 57 percent average for the island and 26 percent to 55 percent average for the sanctuary area (Katon et al. 1997). As a result fish productivity is gradually improving in adjourning areas. In Gilutongan Marine Sanctuary, the average fish catch in adjourning areas increased to 2kg/hr compared to pre-MPA of 2 kg/day (Ross et al. 2002). However, in addition to these positive effects in adjacent areas, there are also negative spillover effects from these non-fishing zones. One of the noted ones is that fishing effort has intensified in adjourning or immediate areas outside of these MPAs. White et al (2005) reported that fish catch increased from 14 to 35 tons/sq km over a ten year period in the outer areas of the protected Sumilon Island.

Cultural services:
Coral reefs play a central role in Vietnam's marine tourism industry. The major recreation activities on reefs are snorkeling and scuba diving. Nha Trang City, for example, is one of the first marine tourism centers in Viet Nam, showcasing its very diverse and abundant coral reefs surrounding the nearby islands. The number of visitors to Nha Trang is increasing (30,000 people in 1995 and 400,000 people in 2003). About ten percent of these visitors participated in diving and snorkeling on the reefs of Hon Mun MPA. These services brought a benefit about US$400,000 and accounted for approximately 2 percent of the total revenue from the tourist sector in Khanh Hoa province. Mangrove areas hold potential for eco-tourism, which contribute to local livelihoods, especially in cases where the natural environment is the main attraction. Protected areas are a major existing and potential tourist attraction. There are a number of ongoing community-based tourism initiatives in Vietnam like Can Gio and Giao Thuy.

Culturally, ecosystem services of mangroves have been sought after and availed by coastal communities through tourism. In 2004, the 75.5 ha Bgy. Buswang park in Kalibo Aklan in the Philippines attracted some 17,000 visitors which generated US$41/ha for the year (Walton et al., 2006). Though not explicitly stated, it can be deduced that the income derived by the local community could have helped the poor households who were involved in providing tourism related services. In its supporting role, Melana et al (2000) on a case study in the Philippines pointed out that mangrove forests produces about 3.65 tons of leaf litter and detritus material per hectare per year which provides a valuable source of food for marine animals and wildlife habitat.

Supporting services:
In Vietnam, a single square meter of seagrass can produce over 25 tons of biomass per year (as cited in Hue et al., 2008), which provides food, habitat, and nursery areas for myriad of adult and juvenile vertebrates and invertebrates. Seagrass epiphytes also contribute to food webs - either directly via organisms grazing on seagrass, or indirectly following the deaths of epiphytes which then enter the food web as a detritus carbon source. Seagrass beds serve as a favourable breeding and hatching ground for numerous marine species, and are important nearshore fishing grounds. Several offshore islands in Vietnam, such as the Hoang Sa and Truong Sa archipelagos were created by the build-up of dead coral skeleton. Many beautiful swimming beaches found in Ha Long and Cat Ba are related to the marine depositional regimes associated with the coral reef production.

Like the mangrove and reef systems, the seagrass areas serves as a nursery, foraging and breeding areas. In Sarawak, the known seagrass area of Punang-Sari-Lawas is especially important to a number of commercial fish species such as *Ilisha elongate*, locally known as "Tahai" which is harvested mostly by traditional fishes for subsistence and local sale. Uniquely seagrass areas are also important in ensuring the survival of a number of endangered mammals and reptiles. This includes the vulnerable dugongs or sea cows, seahorses and endangered green turtles. In Sabah, interviews conducted with fishers and local villagers have indicated that dugongs are encountered occasionally in Tunku Abdul Rahman Marine Park (Jaaman, 2000). During the nesting season, green turtles are found in groups along the coast of Pulau Selingan and Pulau Bakungan Kecil of Sabah. These areas are the nesting ground of the turtles and the presence of seagrass meadows in the vicinity may serve as feeding ground (Japar et al., 2006). Seagrass also serves as seasonal feeding ground for migratory wading birds such as some of the herons and egrets, notably near Lawas, Sarawak.

Besides the case studies above, national stakeholder workshops and focus group meetings were held in selected sites in the Philippines and Vietnam to verify results of the national assessments, derive new information on the dynamics of changes in ecosystem services, and identify knowledge and capacity gaps. A summary of the Philippines and Vietnam national stakeholder workshop and focus group meetings outcome is presented in Box 1 and Box 2.

Box 1: Philippines National Stakeholder Workshop and Focus Group Meetings

A National Stakeholders Workshop was organized by the team from the University of the Philippines-Visayas and held in Manila, Philippines on 5 June 2008. There were 22 participants representing six national government agencies, eight academic/research institutions, and six non-government organizations. These results included:

- There is no dispute about the degradation and even possible collapse of marine and coastal ecosystems.
- Key drivers of decline are globalization, lack of enforcement, climate change, and conflict over resources (conflict triangle: ecological (environment), economic (growth), and social (equity)).
- There is not a knowledge gap but an information gap. Need to better integrate local knowledge into mainstream knowledge. Need to disaggregate information between coastal and non-coastal villages. There is some information on poverty but only on a site-specific often project level. Need to have broader information of poverty at household level to see whole picture in country and its link to ecosystem services. Poverty mapping can generate links between poverty and ecosystems. Information has to be better organized. A lot of assumptions about the poor exist but there is less quantitative data.
- There is more known about provisioning services than other services. There is a real lack of knowledge on other ecosystem services such as supporting, cultural and regulating and their link to poverty.
- The government, academe and research institutions, and the civil society already know enough about the changes in the ecosystems. There are serious institutional and implementation issues why we can't seem to overcome the environmental degradation and poverty. Poor governance is a real issue to addressing poverty alleviation and ecosystem services. There is lack of institutional recognition at local government level of a problem. Lack of political will to deal with issues. Local governments are the key to addressing this issue.

Focus group meetings were held with coastal residents in two villages in Cavite (south of Manila) on 6 June 2008 and in three villages in Iloilo in late May 2008. Important ecosystem services include livelihood and food. It is notable that reference to corals, mangroves and seaweeds did not spontaneously come to their mind, but had to be directly asked. This means that they do not necessarily connect the benefits they derive from coastal/marine resources to these ecosystems. They may be oblivious or take for granted that fish or shells/bivalves come from some ecosystem which needs to be managed. Unfortunately they think that this source is inexhaustible. The ignorance of how ecosystems operate contributes to reckless exploitation of the resources, which worsens poverty.

Box 2: Vietnam National Stakeholder Workshop and Focus Group Meetings

A National Stakeholders Workshop was organized by the team from the Vietnam Marine Science and Technology Association (VIMASTA) and Centre for Marinelife Conservation and Community Development (MCD) and held in Hanoi, Vietnam on 30 May 2008. There were 30 participants representing six national government agencies, nine academic/research institutions, five civil society and non-government organizations, and six international organizations/agencies. The results included:

- Most participants considered provisioning services the most critical to the poor as they provided food and livelihoods for local people. Several participants, however, agreed that storm protection and tourism were the most important services of marine and coastal ecosystems.
- The participants all agreed that marine and coastal ecosystem services are becoming seriously degraded in Vietnam. All participants agreed that knowledge on changes in marine and coastal ecosystem services are very limited.
- Increasing resource decline and poverty is correlated with increasing population within Vietnam's coastal zone.
- Key factors that drive these trends include nearshore overexploitation and destructive fishing; unsustainable aquaculture, industrial and land based activities; the effects of climate change, poor coastal resources management and enforcement; increasing market demand for marine products; poverty and low livelihood resilience.
- Vietnam's entry to WTO will increase demands on natural resources, for export, and impact on poor who cannot access markets and will lose resources.
- Times series quantitative data are lacking for analyses of the links between poverty alleviation and ecosystem services. There is a lot of anecdotal and qualitative data. Data are not shared among different levels of users (government, academics). There is limited information on poverty at site-specific project level but this is not broad. There is not much information at household and village levels.
- Dynamics of the link between poverty alleviation and ecosystem services is needed. There is very limited knowledge of links between poverty alleviation and ecosystem services in Vietnam.

Two focus group meetings were held with coastal residents Van Hung Commune, Van Ninh District, Khanh Hoa Province on 24th May 2008 and in Giao Xuan Commune, Giao Thuy District, Nam Dinh province on 28th May 2008. Both communities considered food supply, a provisioning service, as the most important service that they benefited from marine and coastal ecosystems. Regulating services such as flood and storm production or reduction were also identified. Local people have witnessed degradation of marine and coastal ecosystems in their communes and this is leading to more poverty. Poor law enforcement is also one of their concerns for resources management in their communes.

4.2 Knowledge Gaps

There are a number of knowledge gaps that will inform the development of a research strategy to support the maintenance of ecosystem services explicitly for poverty alleviation. In particular the following knowledge gaps can serve as inputs to the planned five year ESPA-NERC research program:

1. Studies on the cultural, spiritual and ceremonial significance of the seas and coastal ecosystems, as well as their psychological and aesthetic contributions to coastal communities, have not found their way into the literature in the past couple of decades. The cultural value for those who live in proximity (particularly the poor) to the sea has not been given much attention.

2. While various studies have shown the vulnerability of marine species and ecosystem to overexploitation, how people (particularly the poor) value these species and associated habitats and ES needs be researched and understood. This knowledge can guide and inform future research strategy and policy.

3. There is lack of recognition of the non-material indicators of poverty/well-being within the literature on ecosystem services. The cited links to poverty are chiefly monetary income from increased catch and tourism services. However there is scant discussion of the impact of interventions on health, nutrition, education, social networks and relationships. This absence reflects the narrow view that poverty alleviation can be handled simply by increasing incomes and material well being.

4. The most appropriate context and role of ESPA in the larger framework of integrated coastal management (ICM) or integrated coastal zone management (ICZM) need to be identified. This is indeed a vital input in the development and implementation of the planned ESPA-NERC research program.

5. Demographic research on coastal communities is needed to capture the dynamics connecting population growth and depletion/sustainability of coastal resources.

6. How may fruitful interdisciplinary studies in ecological systems cum poverty research be optimally undertaken, avoiding the trend in the past where natural scientists focus only on the biophysical to the exclusion of the social science aspects and vice versa. Similarly some CRM studies look only at governance issues and ignore the biophysical indicators, when both need to be interrelated to optimize learning and sharpen analysis.

7. There is an absence of delineated studies on mudflats (which provides provisioning and regulating services to the poor) which is often overlapped with mangrove ecosystem.

8. Data and information about marine and coastal ecosystems are largely available; the understanding about services and values they provide for human being is very limited.

9. Knowledge of poverty in the coastal zone is limited and outdated**.** Poverty in coastal areas needs to be studied thoroughly in the broader context of social development and justice. Specifically, what factors facilitate or prevent the poor to access ecosystem services and how to promote or limit these factors? Furthermore, the adaptive capacity of key stakeholders to address the issues mentioned above need to be elucidated.

10. Knowledge of the linkages between ecosystem services and poverty in the coastal areas of the region is limiting. Quantitative data to demonstrate the linkages between ecosystems services and poverty is still limited and a major study on increasing the access of poor people to benefits from ecosystem services should be conducted. Future research needs to analyze in depth other aspects of ES and poverty alleviation within the context of specific provinces and in particular address the question of how people employ ecosystem services aside from the capture fishery, for an example: fishers may use coral reefs for supporting eco-tourism, or aquaculture as an alternative to capture fisheries. Furthermore, other factors should be incorporated into the assessment of poverty alleviation such as distance from main land (offshore islands), distance between the fishing communities and the city/town, infrastructure influencing the transportation of goods, etc. Very few previous studies deal with the linkages between the reduction of ecosystem

services (eg. typhoons, floods) and the poverty conditions of fisher communities in the coastal lagoons. In Vietnam, 80 percent of the population depends on wetlands where lagoon system provides most services, so there is clearly a need to conduct such studies.

4.3 Policy Options

To address ecosystem services and poverty alleviation in coastal areas in the long term, it is suggested that relevant national policies and strategies are formulated and enacted. Several possible policy options could be:

1) Co-management is applied in fisheries management, with enforcement and support from both the government and community
2) Ecosystem based management approach is introduced and applied widely to improve the rehabilitation and productivity of the ecosystems to sustain their services for the benefits of human well-being;
3) Integrated coastal zone management (ICZM) to enhance the planning of coastal zone and coastal resources uses, the cooperation of responsibilities between different stakeholders and the coordination of actions related to coastal areas
4) Private-public partnership should be studied and examined as an option to better manage and sustain the resources in allocating user rights and ownership of the resources

Chapter 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

Identified root causes of habitat loss and community modification, pollution, and unsustainable exploitation of fish and other living resources in the SEA region are population growth coupled with widespread poverty and international market trends. Population growth is impacting on migration, urbanization, lack of employment and poverty, all of which, in turn, place greater pressure on services provided from the environment (e.g. fish resources) and contribute to increased pollution and damage to habitats. The near-total dependence of millions of poor people in the region on natural resources for their subsistence is so strong that every available resource is being extracted at all cost. Extreme poverty has forced people to continue fishing despite resource depletion. As the situation worsens, fishers will resort to use of all methods to catch remaining resources. Economics and international market trends, including the insatiable international demand for seafood, also drive the unsustainable use of resources, and foster corruption and illegal practices. Coupled with the burgeoning population, poverty, and migration to coastal and urban areas, market trends create a dangerous mix of driving forces.

Rapidly growing coastal populations, increasing levels of poverty, greater commercialization, declines in resources, lack of effective regulation, and poor/nonexistent enforcement are expected to cause significant future deterioration in ecosystem services, with likely severe socioeconomic hardship, particularly for the majority of the poor rural population. Illegal activities have significant environmental and socioeconomic impacts. Progress in managing these multifarious impacts and threats is not expected to be sufficient to mitigate fully the damaging effects of population growth, poverty and the other driving forces.

Poverty, overpopulation and limited access to other forms of livelihood for rural coastal dwellers are all factors that continue to impact on overexploitation of inshore fisheries and other living marine resources. Almost everything from the sea will be eaten or otherwise used, unless it is harmful. Biodiversity, protection of native stocks and environmental management are complex questions to explain to people who are at subsistence levels reliant largely on their immediate environment for food.

5.2 Priorities for Regional Research and Capacity Building

The assessment has identified the following priorities for research and capacity building in the SEA region:

1) Prioritization of key data and information required for developing and refining policy, legislation and interventions related to ecosystem services and poverty alleviation at national, regional and local levels.

2) Development of quantitative data to demonstrate the linkages between ecosystems services and poverty is still limited. Many of the data are qualitative and anecdotal, based on individual project activities or site specific, and are not presented in a comparative manner.

3) Study on increasing the access of poor people to benefits from ecosystem services, including, for example, tenure and property rights, markets, and market access (distance from main land (offshore islands), distance between coastal communities and the city/town, infrastructure influencing the transportation of goods, etc.).

4) Research needs to analyze other aspects of ecosystem service and poverty alleviation within the context of specific locations, and in particular address the question of how people employ ecosystem services aside from capture fisheries (for example; coastal dwellers may use coral reefs for supporting eco-tourism or cultural purposes).

5) Building or expansion of partnerships at local, provincial, national and multilateral levels, in governments, international organizations, NGOs, and the private sector, in research and development and implementation.

6) Promoting a united call to establish national and regional database(s) and monitoring that allow for periodic assessments of key coastal ecosystems and poverty.

7) The links between ecosystem services and poverty alleviation in the SEA region require a better understanding of the diversity of coastal people and communities, especially in relation to their livelihood strategies. It also requires understanding the means by which households adapt to reduce their risks, the incentives that drive the decisions of resource users, and the sources of their vulnerability to stresses and shocks.

8) A priority area of research in the region is on population growth and its impact on migration, urbanization, lack of employment and poverty, all of which, in turn, place greater pressure on services provided from the environment (e.g. fish resources) and contribute to increased pollution and damage to habitats.

9) Very few studies have addressed the linkages between the reduction of ecosystem services from natural (eg. typhoons), political, economic, and peace and order events and the poverty conditions in coastal communities.

Annex 1: Summary of ES and poverty linkage in SEA region

Ecosystem Type	Ecosystem Service	Ecosystems involved	Poverty Link	Trends & drivers	Trade-offs	State of knowledge	Knowledge gaps
Regulating	Protection of coastal areas and agricultural land from natural hazards such: waves, storms and flood	MANGROVES CORAL REEFS COASTAL FORESTS SEAGRASS	Protects homes, properties (largely built on weak foundation) safety of families and livestock	Protection services have declined as a result of logging and conversion to aquaculture ponds	This service declining as increase in aquaculture. Fishpond leases go to the rich and middle class due to their influence and capital while the poor are deprived of fish products affected by loss of mangroves.	Data estimating national hectare of mangroves cleared for aquaculture purpose Records of extreme flood events/ catastrophes in areas where mangroves and coastal forests have been cleared	The perception of risks in different people – how this feeds into adaptive capacities and risk minimizing actions (more work in developed countries, less has been done in developing countries with people of different poverty profiles The synergies between different forms of risk – interactions of slow and gradual changes with sudden unpredictable changes
	Water supply	COASTAL FORESTS CATCHMENT AREAS OPEN OCEAN	Regulating quality and quantity of water supply to coastal households	This service comes under threat with coastal development and growing urban slums	This service declining with increasing coastal settlements	It links to human well-being through health impacts and time spent in collecting water	
	Erosion control	BEACHES COASTAL FORESTS SEAGRASS MANGROVES CORAL REEFS	Protects local agricultural production, sustains the beauty of the beach for tourism	Coastal erosion is a major problem and is likely to increase.		It affects coastal people's livelihoods, health, incomes and their security. The poor are increasingly vulnerable to this threat. Erosion control is provided by a number of coastal systems including mangroves, coral reefs and other coastal forests. A good number of national studies linking modification of coastal systems, migration and urbanization to coastal erosion.	How much this will contribute to increasing numbers of people falling into poverty. A projection of number of people at risk in different places, especially in rapidly developing coastal areas.

Ecosystem Type	Ecosystem Service	Ecosystems involved	Poverty Link	Trends & drivers	Trade-offs	State of knowledge	Knowledge gaps
	Climate regulation	COASTAL FORESTS MANGROVES SEAGRASS	Climate related changes in season and storm patterns, e.g.: rainy seasons, causing loss of livelihood opportunities, harvest and loss of property	Increasing trends in occurrence of climate induced events (El Niño, la Niña, typhoons, droughts) - economic losses due to severe storms	Conversion of coastal wetlands result in the release of large quantities of carbon dioxide, changing carbon sequestration, inducing climate change	Damage assessment reports; storm data – e.g. University of Hawaii (http://www.solar.ifa.hawaii.edu/Tropical/)	Regional studies on awareness of values or benefits derived by people from the regulation of ecosystem processes, such as climate regulation, erosion control, water purification, regulation of human diseases.
	Pest and disease control	COASTAL FORESTS MANGROVES	Biologically rich ecosystems consist of numerous organisms that interact with each other in complex ways resulting in naturally controlled pests and diseases, saving farmers from the need to invest in expensive chemical pesticides and their harvest.	Increasing use of chemical pesticides, unregulated use on agricultural farms close to the coast is contaminating water and soils	This service declining as coastal forests are cleared for agriculture, housing, industrial projects		
	Waste processing	MANGROVES WETLANDS SEAGRASS	Waste are assimilated and processed, preventing unhygienic conditions in settlements	Loss of these ecosystems are undermining this natural process affecting people living in situ and those downstream			Carrying capacity/ assimilative capacity of systems to support these services – how do these systems behave in terms of slow degradation
	Larval productivity and dispersal	DEEP OCEAN ISLANDS	Coastal fishing opportunities	Increased fishing pressure around islands causing reduced larval productivity and dispersal from Spratly islands.	Reduced coastal fishing opportunities		
Provisioning	Subsistence and commercial fisheries	MANGROVE CORAL REEF SEAGRASS SOFT BOTTOM HABITATS DEEP OCEAN	Seasonal employment for coastal folks, fishers income, opportunities to join as crew members in commercial fisheries	Lower volume of fish catch	Trade offs in time between short term yields and long-term sustainability	Contribute of fisheries production to total national fish production is stagnating. Demand for fish protein intake is increasing. A general heavy dependency of coastal population in the region on fisheries due to lack of diversification in livelihoods	How to improve adaptive capacity of small scale fisheries in order to ensure sustainability.

Ecosystem Type	Ecosystem Service	Ecosystems involved	Poverty Link	Trends & drivers	Trade-offs	State of knowledge	Knowledge gaps
						and low education levels.	
	Aquaculture ground	MANGROVE	Additional household income	Aquaculture is the fastest growing food production sector and accounts for almost 40 percent of the worlds' fish production.	Loss of regulating services when mangroves are cleared to accommodate fish ponds.		Viable and sustainable pro-poor aquaculture development strategies.
	Building material such as timber and pulp/chipwood from commercial forestry	MANGROVE COASTAL FOREST	Locals employed by logging companies, housing developers	In 1950s, mangrove logs were exported to Japan to meet growing demand of rayon market. Today logging is done to supply for housing developers	Loss of natural habitat		Publicly published information on areas gazetted for logging and reserves
	Subsistence and commercial extraction of fruits, honey, leaves, wood by households	MANGROVE SEAGRASS	Women are able to earn income by utilizing their skills to make cigarette covers, weave thatches and make handicrafts. Medicine extracted from mangrove provides cheaper alternatives to commercial medicines.	Gradual loss of resource use due to logging and conversion of mangrove areas	Loss of natural habitat		
	Propagules for reforestation programs	MANGROVE COASTAL FOREST	Locals employed in propagule nurseries & planting effort	Increasing recognition and efforts to conserve and/or restore coastal resources through community based programs		Growing awareness, appreciation and vigilance on the natural environment and conservation issues, especially post-tsunami	
	Off-shore oil	DEEP OCEAN	reduced fish productivity, loss of habitat, reduced quality of nutrition, loss of access to fishing areas	destruction of coastal habitats - invasive, oil spills; dredging of oil tankers for navigation	Job opportunities on oil platform for locals, economic development in near-shore areas		Extent of seabed under exploration; area of exclusion for fishers

Ecosystem Type	Ecosystem Service	Ecosystems involved	Poverty Link	Trends & drivers	Trade-offs	State of knowledge	Knowledge gaps
Cultural	Recreation and tourism	BEACH CORAL REEF COASTAL FOREST ISLANDS MARINE BIODIVERSITY OCEAN	Employment opportunities and regular income for coastal communities especially younger generation, breaking off the generational cycle of being fishers	Growing number of thriving tourism related enterprises that are located in coastal areas. Tourism tends to be poorly regulated and easily result in ecological harm: poor water quality, inadequate sewage, illegal land use in many cases	Increase in prices of goods due to tourist trade will offset any income gains for the poor; opening coastal and marine zones to economically- driven tourism creates conflicting use with traditional users.	Tourism generates significant income for national economics and local communities. Case studies at local level which indicates that fishers still fish, not content with income from tourism, so fishing pressure is still there.	Longer term prospects for international tourism; Ecotourism impacts and whether it really changes perceptions and behavior towards the ecosystem.
	Coastal & marine protected areas /sanctuaries	MANGROVE CORAL REEF SEAGRASS ISLAND	Marine conservation projects in most cases involve alternative livelihood components, which addresses low income among locals	Increase in alternative livelihood testing schemes/projects, including access to microcredit, skill training. Preservation and rehabilitation of coral reefs continue to generate national and international interest and cooperation. Increasing awareness on recreational value of mangroves e.g. development of mangrove parks as alternative conservation strategy (recent trend)	Spill-over effects of protected areas, fishers tend to practice intense fishing effort in areas adjacent to the marine protected areas or fish sanctuaries	Wide information generated and disseminated on value of establishing marine protected areas and/or fish sanctuaries. Improved natural and social (if local communities are actively involved) capital. Digitalized maps on coral reef sites under MPA management - UNEP-WCMC website	Comparative studies on the cultural value of reefs and mangroves for those who live near them versus tourists. Do the locals derive the same cultural benefits as tourists?
Supporting	Sediment and nutrient cycling	COASTAL FOREST MANGROVE SEAGRASS	Water quality improves, prevents contamination of groundwater supplies which coastal community depend on	Increasing number of coral reefs and seagrass beds are damaged from siltation that flows into the ocean from the coastal areas as mangroves and other form of vegetations which usually acts as buffers are removed	Mangroves are directly cleared to give way for coastal development; this indirectly affects aquatic resources in the ocean.		
	Feeding ground for dugong, green turtles and	SEAGRASS	Increasing number of tourists pay to see dugongs	Declining number of the endangered dugong and green turtles	Loss of tourism revenue	The declining number is linked to human activities, including dugongs and turtles trapped in	Empirical link between declining ES and declining number of

Ecosystem Type	Ecosystem Service	Ecosystems involved	Poverty Link	Trends & drivers	Trade-offs	State of knowledge	Knowledge gaps
	migratory birds					fishing nets & caught for consumption.	species that depends on this ES for survival
	Habitat and nursery ground for fish, shrimps, starfish, sea cucumbers, bivalves, gastropods and seaweeds	MANGROVE CORAL REEF SEAGRASS	Direct source of food and livelihood support for coastal communities, especially fishing families	Increasing habitat degradation caused by growing number of industrial companies close to coastal areas. Increasing coastal pollution caused by effluents from growing number of households/squatters and industries along the coast.	This service is declining, which threatens the livelihood of fishers but it is done at the expense of coastal development for the purpose of housing, employment and infrastructure – benefits to local coastal population.	Total area of mangroves cleared for development. Valuation studies on the ecosystems versus physical developments.	Regional studies on the importance of other systems as habitats for aquatic resources and its relation to coastal communities. In most cases, other systems, such as mudflats and wetlands are generalized under the mangrove ecosystem.
	Habitat for ornamental species	CORAL REEF ISLAND OFF SHORE SEAGRASSES	Expanding market for export of ornamental species, local fishers hired to harvest these particular species	Increased exploitation due to the need for trade; demand for ornamental species increases, habitat damage as a result from destructive methods used to harvest ornamental species, just to meet the demand of international markets	Loss of opportunities for local fish consumption; lost of coastal protection.	Ornamental trade data from Global Marine Aquarium Database, World Conservation Monitoring Centre (http://www.unep-wcmc.org/marine/GMAD/index.html)	The number of coastal fishers involved in this trade

ANNEX 2 – PHILIPPINES COUNTRY ASSESSMENT REPORT

Submitted by:

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1. INTRODUCTION

This national analysis for the Philippines aims to assess the state and trends in ecosystem services associated with marine and coastal systems; driven factors; how they support the livelihoods and well-being of human societies and particularly poor communities in the Philippines. It also identifies the key challenges for research, as well as current gaps in knowledge and capacity in order to inform the development of a research strategy to support the maintenance of ecosystem services explicitly for poverty alleviation.

1.1. Coastal and marine ecosystems of Philippines

The Philippines is the world's second largest archipelago next to Indonesia, with more than 7,100 islands within 2,200,000 square miles of its territorial waters. It is among the world's most megadiverse countries with more than half of its 52,177 species found nowhere else in the world (Ong *et al.* 2002). The coastal and marine resources of the country is at the apex of global marine conservation having the first functional marine protected area initiated by Alcala and colleagues and recently considered as the hottest of the hotspots (Roberts et al. 2002) and the center of marine biodiversity (Carpenter et al. 2006).

The country has 419 river systems which drain into what is considered as the world's longest discontinuous coastline with an estimated span of 22,540 kilometers (DENR 2001; PTFWRDM, 1998). About 117,700 hectares of mangrove forests and more than 34,000 hectares of seagrass beds act as biofilters and recipients of organic matter deposition from the terrestrial habitat channeled through these rivers. This natural process upholds nutrient to energy conversion beneficial to some 40 mangrove species (Primavera, 2000), 16 species of seagrass (Fortes and Santos 2004) and 820 species of algae (Trono 1999). Consequently, the mangrove-seagrass and algae ecotone and local hydrographic dynamics mitigate the extreme effects of siltation, relieving some 464 species of scleractinian corals (Licuanan and Capili 2003, Veron and Fenner 2002), 736 reef fish species (Allen 2002) and 648 species of mollusks (Wells 2002).

The various coastal and marine ecosystems in the country possess varied and tremendous amounts of ecosystem services which need to be sustained and conserved for intra-temporal and inter-generational equity. The following provides an overview of the few key coastal and marine systems in the country:

1.1.1. Coral Reefs

The Philippines, with an estimated area of 25,000-33,500 square kilometers, has one of the most extensive coral reef areas in the world, second only to Indonesia (Alino et al. 2004, Burke et al. 2001, Carpenter and Alcala 1977, Gomez et al. 1994). Although detailed information is not available to classify and provide an exact estimate of the health status of the entire coral area, information from literature indicates over seventy percent (70%) of these coral reefs are in poor or fair condition and 5% are found to be in excellent condition (Gomez et al. 1994).

Coral reefs contribute significantly to protein supplies in a country where more than 50% of animal protein is derived from marine fisheries and aquaculture (White and Cruz, 1998). In the early 80s', the contribution of reef fisheries in the Philippines ranged from 15 to 30% of the total national municipal fisheries production (Carpenter and Alcala 1977; Murdy and Ferraris 1980). This accounted for almost 10% of the total fish production in the Philippines. More than one million small scale fishers are estimated to depend directly on reef fisheries for their livelihoods. Yet reviews of catch rates in the 90's and early 20's (Dalzell 1996 and White et al. 2000), suggest that Philippine catch rates are among the lowest in the world. This may be the result of overexploitation and destruction of reef habitats although the high diversity of Philippine reefs may have helped in its resilience to fishing pressure (Alinio et al. 2004; Alinio and Dantis, 1999).

Of the 83 coral reef monitoring sites from 34 municipalities/cities and 15 provinces surveyed from 1991 to 2004, 55 percent of the sites indicated a decreasing trend in coral cover. Results from the 424 transect sites surveyed from March 2000 to June 2004 representing 6 of the bio-geographic regions in the country indicated that majority of the sites have either fair or poor coral cover with only a few having good to excellent live coral cover estimates (Figure 1A). Results from the 763 reef monitoring sites surveyed from April 2001 to April 2004 (Figure 1B), indicated that majority sites were classified as having low to very low

fish biomass (0-10 mt/km^2) particularly those in Northern Philippines Sea, Visayas and Southern Philippine Sea biogeographic regions (Nañola *et al*., 2004 – in ICRS, Okinawa Japan).

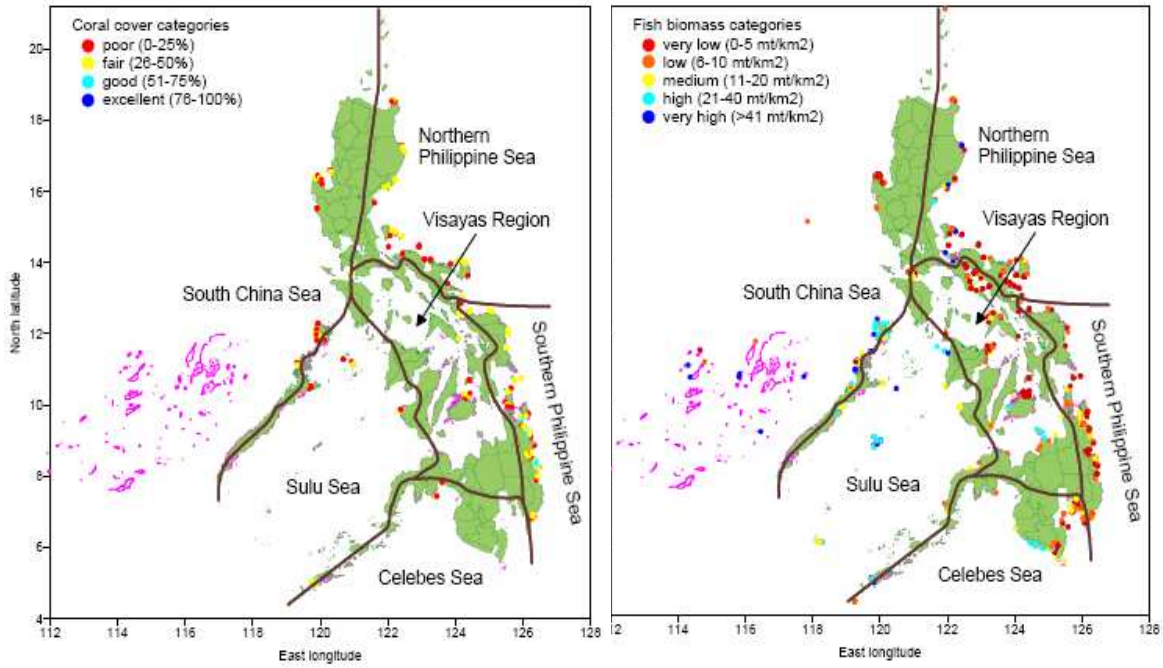


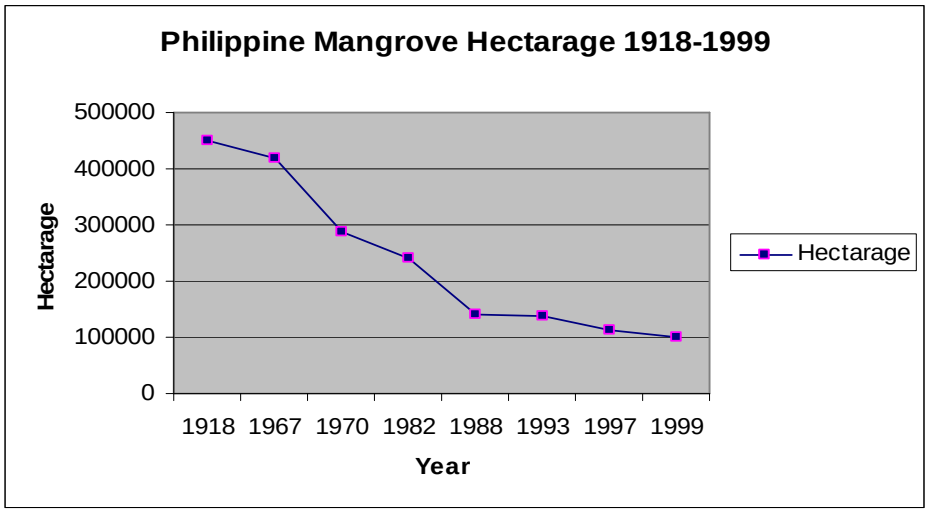
Figure 1A & 1B: Philippine map and its biogeographic regions (Aliño and Gomez 1994) showing the color coded live coral (HC+SC) cover (map A) and reef fish biomass (map B) classification based on data from 1991 to 2004.

1.1.2. Mangrove Forests

Mangroves act as a buffer protecting seagrass beds and coral reefs from siltation and at the same time preserving the integrity of the coastline by significantly reducing wave driven erosion. Mangrove forests play an important role on global climate regulation by sequestering about 1.5 tons of CO^2 per hectare per year. There are 54 true and 60 associated mangrove (40) species belonging to 14 families of true mangroves in the Philippines (Tomlinson, 1996).

Figure 2 shows how the mangrove resource of the Philippines has declined through the years since the start of the 20th century. Among the obvious causes of mangrove habitat loss is its conversion for commercial and residential use. In 1950s, mangrove forests in the country were awarded to concessionaires for firewood and tanbarking. A greater portion of logged mangroves were exported to Japan, later assumed to be the source of rayon. In 1960s, the Philippine government enacted a policy to increase fish production by offering loans for aquaculture thus converting mangrove forests to milkfish and shrimp ponds. Within the period, about 4,000 to 5,000 hectares of mangroves were converted to fishponds annually (Melana *et al.*, 2000, Primavera, 2000).

Figure 2: Philippine Mangrove Hectarage



Sources: White & De Leon, 1996; Aypa & Baconguis 2000; NWPF 2000

Mangrove rehabilitation initiatives in the country started as early as 1964 with locals from Getafe, Bohol reforesting about 100 hectares. In 1968, students and school officials in Calape, Bohol reforested 20 meters in about 4.8 kilometers of coast to protect it from storm surges (Yao, 1986). Then from 1970s to 1990s various national efforts were made to rehabilitate lost mangrove habitats in the country through the organization of a National Mangrove Committee under the Ministry of Natural Resources and a Mangrove Forest Research Center under the Forest Research Institute of the Philippines. Succeeding national efforts likewise include the declaration of islands with an aggregate mangrove area of about 4,000 hectares as Wilderness areas under Presidential Proclamation No. 2151 of 1981, the establishment of protected areas under the NIPAS Act of 1992, the launching of Coastal Environment Program (CEP) and the Coastal Resource Management Project under DENR in 1993 and 1996. Success indicators that would describe the present state of mangrove forests in the country in relation to rehabilitation initiatives under the aforementioned programs and policies are however patchy.

1.1.3. Seagrass Habitats

Seagrass beds are a discrete community dominated by flowering plants with roots and rhizomes, thriving in shallow coastal waters. Seagrasses are functionally linked to coral reefs and mangroves (Fortes 1988, 1991, 1995). They slightly reduce sediments and normally exhibit maximum biomass under conditions of complete submergence (Fortes 1995). Seagrass meadows support a rich diversity of species from adjacent systems and provide primary refuge for both economically and ecologically important organisms. They are sensitive to environmental fluctuations and thus are useful indicators of changes not easily observable in either coral reefs or mangrove forests (Fortes 2004). To date, around 16 seagrass species have been identified in the Philippines (Fortes, 1986, IUCN Red Listing Workshop, March 2008).

From surveys in 96 sites, a total of 978 km2 of seagrass beds have been identified in the country, mostly in northwestern, western and southern portions, with outlying islands having sizable beds (Fortes 2004). A significant portion of the coastal habitats is at high risk of being lost in the next decade. About half have either been lost or severely degraded during the past 56 years (Chou 1994; Fortes 1994). Estimates on the total area of seagrass habitat in the country is lacking and the use of remote sensing techniques would necessitate enormous and well designed ground-truthing as seagrasses are usually interspersed with algal and shallow coral habitats. Of the total area identified thus far, 343 km2 have been estimated using combined satellite images and ground truth surveys. On the other hand, 635 km2 are gross estimates from satellite images only (involving no ground truth surveys) as the places are clusters or parts of big islands, and they cannot be delimited by single grids (Fortes 2004).

1.1.4. Fisheries in the Philippines

The fishery sector of the Philippines is divided into three sub-sectors which are: aquaculture, commercial fisheries and municipal fisheries. Based on the Philippine Fisheries Code of 1998, municipal fisheries is defined as fishing without using vessels or with vessels of 3 GT or less and commercial fisheries as fishing with vessels of more than 3 GT. Fisheries in the country provide some 1.6 million income generating opportunities with 85% of it filled by municipal fisherfolks (2002 Census of Fisheries).

Fisheries production (figure 3) in the country has shown an enormous increase from 1950s to late 80's. In the period of 70s to 80's, that maximum sustainable yield (MSY) was attained. The continuing increase in total production after the '80's is less steep than in the 60's-70's, in spite of technical improvements in gear/navigation and expansion of fishing grounds farther from shore. Actual catch ratios recorded during this period are very low, but multiplied by the large number of fishers and vessels, the total catch is actually high, although way past the level of sustainability. Harvest rates were already at the upper limit of what the fishing grounds could naturally produce at the time.

From 1997 to 2006, fisheries production contributed an average of 2.2% to the country's GDP (BFAR 2006). However, the continuing increase in total fisheries production is attested by the growth of aquaculture. In 2006, nearly half of the fisheries production (47.5%) came from aquaculture clearly indicating that despite an increasing trend, marginal fisherfolks are catching fewer fish. Also an important point to be noted is that about 70% of the aquaculture production is contributed by mariculture of seaweeds which is carried out in sub-tidal areas of the coastal zone and mainly operated by small-scale fish farmers.

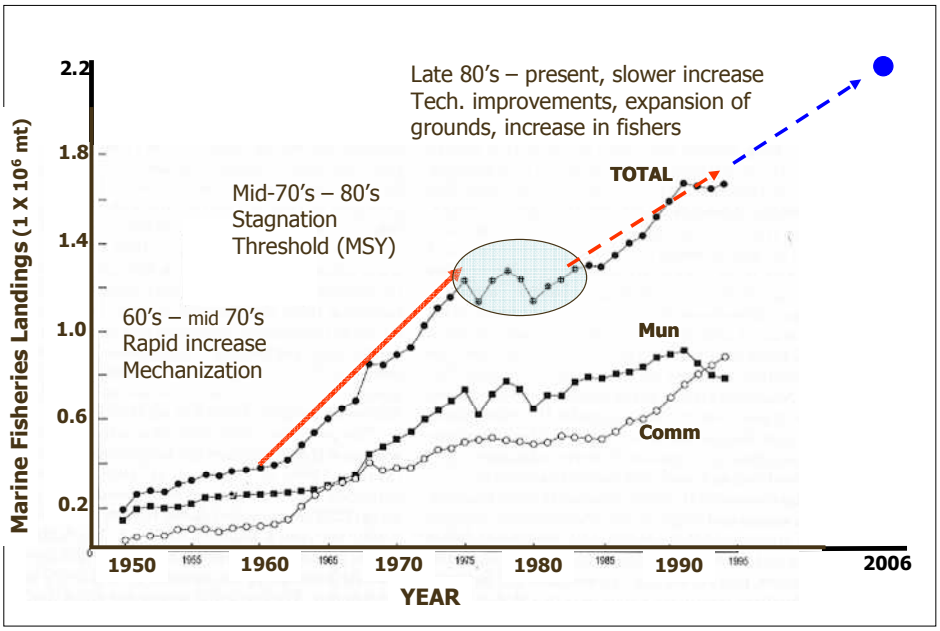


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Figure 3: Trends in Philippine Fisheries from 1950 to late 90's (Armada and Campos 2004).

1.2 Poverty in the Philippines

Poverty statistics in the Philippines follow a cost of basic needs (CBN) approach, in which poverty lines are calculated to represent the monetary resources needed to meet the basic needs of the members of a household, including an allowance for non-food consumption. In the current methodology used by the National Statistics Coordination Board (NSCB), poverty lines are estimated at provincial levels, computed separately for urban and rural areas. About 50% of the approximately 88 million Filipinos live in rural barangays (villages). Poverty incidence is defined as the percentage of families/individuals with per capita income/ expenditures less than the per capita poverty threshold.

The Phil has an official poverty incidence of 26.9% of families or 32.9% of individuals (NSCB, 2006) which is an increase from 24.4% and 30% respectively in 2003. Thus 4.7 million families were poor in 2006 or 27.6 million poor individual Filipinos. A Filipino family of five needs PhP 6,274 monthly income in 2006 to stay out of poverty and PhP 4,177 to live above the food threshold.

A separate methodology was used to estimate poverty incidence, poverty gap, and poverty severity for the provincial and municipal levels (NCSB-World Bank 2005 Estimation of Local Poverty in the Philippines). The methodology combined the 2000 Family Income and Expenditure Survey (FIES), 2000 Labor Force Survey (LFS) and 2000 Census of Population and Housing (CPH).

The UN Human Development Index (HDI) is also computed on a triennial interval drawing from income figures generated through the FIES survey, the Department of Education literacy rates data, and life expectancy statistic of NSO. The combined indicators are transformed into index figures ranging from zero to one; the higher the index, the greater the level of development attained. The HDI is used by the NSCB to quantify level of development attained by provinces and allows for comparison of national level of the index with levels of other countries. However the index is not reported at a level where coastal units are disaggregated from non-coastal.

An ADB report (Schelzig 2005) analyzed country poverty using a framework incorporating the more traditional concept of income poverty with access poverty. Access poverty takes off from a sustainable livelihoods approach (SLA), and measures poverty in terms of deprivation of five different types of assets: human, physical, natural, financial, and social capital. Access to these assets helps reduce vulnerability and to keep people out of poverty.

1.2.1 Population and poverty in coastal zones

The estimated population of the Philippines is 88 million (2007) with an annual growth rate of 2.4%. About 80% of the country's provinces, two-thirds of its municipalities and 17 of its 25 largest cities are located in the coastal areas (Guieb, Turcotte, Alexander, Pangilinan, & Santos. 2002**)**. The NSO 2000 data found the highest incidence of poverty (62%) among the agriculture, fishing and forestry sectors. The poverty incidence reported in the NSCB-World Bank report (2005) showed that for 804 coastal municipalities/cities the small-area estimate of poverty incidence was 0.4915 compared to 0.4198 for the non-coastal group, which supports the observation that residents in coastal villages tend to be poorer.

The poor in coastal areas includes a predominance of the subsistence/ artisan/municipal fishers (engaging in various types of fish capture and fish culture activities) who may also engage in opportunistic non-fisheries livelihoods; landless agriculture workers such as the laborers in rice and sugar fields and fishponds, and those who derive some income from mangroves; occasional laborers in construction, and possibly also small landholder beneficiaries of CARP with large families and meager means. A number of the non-fishers may also engage in fishing as a secondary income source, resorted to when their primary source is weak or on off-season.

An analysis of 2000 NSO data by Israel (2004) showed that in 2000, fisher-headed households had significantly higher poverty incidence (61.9%) than households in general (33.7%). The same source also showed that the difference in poverty incidence and annual income between families whose heads were fishers and those (59.9%) whose heads worked in the fishing industry (e.g. boat hand, engineer, and accountant) was small. This highlights the generally deprived conditions of most employed persons in the fisheries sector, whether they are in the formal sector or outside it. A contrary finding is reported by Tietze, Groenwold & Marcoux (2000) that the average annual household income of fisherfolk households is still significantly higher than households in neighboring agricultural villages of the sample areas that they studied in the Philippines.

Employment in the fisheries sector is about 1.6 million (2002 Census) or about 5% of the country's labor force and consists of municipal fishers, commercial fishers and workers in the aquaculture sector. See Table 1. Although municipal fishers are the most numerous in the fishing sector, they account for only 28% of the annual fish production (2006), while aquaculture assumes about 48% and commercial 24%.

Table 1: Employment and Production in the Fisheries Sector

Fisheries subsector	Number Employed (a) (2002)	%	Quantity (MT) (2006) (b)	%
Aquaculture	226,195	14.0	2,092,275.8	47.5
Municipal	1,371,676	84.9	1,235,528.8	28.0
Commercial	16,497	1.0	1,080,667.7	24.5
Total	1,614,368	99.9	4,408,472.3	100.0

Based on Census of Fisheries, 2002; (b) Based on BFAR, 2006.

Some indicative statistics were obtained where available. Data reported on the twelve priority bays studied under the Fisheries Sector Program (FSP; 1990-1994) profiled the socio-economic conditions of fishers at the start of the program. Average annual household income was approximately P25, 426 (1992). The format of available data was not standard across the different bay reports, so a comparison of income among bays is not easily available. However, illustrative cases may be cited on Ormoc, Calauag and San Miguel Bays. In Ormoc Bay (FSP, 1993) the average monthly income is P1,489 monthly or P17,868/annum with 94% of respondents having monthly incomes of P3000 or less. In San Miguel Bay, fishing incomes of most operators lie below the poverty threshold of P4000/month except for fish corral operators. In Calauag Bay, modal annual income ranged from PhP3,000 to PhP 5,000.

The resource and socio-economic data generated in Fisheries Resource Management Project (FRMP) (1997-2005) provide an informative profile of poverty among fishers as represented by the ten study bays. The analysis undertaken by BFAR-FRMP (2006) in Sustainable Philippine Fisheries Agenda (SuPFA) of these bays, showed that fishers in four of the bays had household fishing incomes above the national annual per capita poverty threshold levels of P11,906. The per capita annual income from both fishing and non-fishing sources in the four bays was PhP 20,000. On the other hand, those below the poverty threshold had an annual per capita income of PhP 10,000. It may be noted that the aforementioned income is above the food threshold in 2000 which was PhP7,707. The advantage of the better-off bays over those below the poverty threshold are i) higher productivity levels, ii) relatively lower fisherfolk density (not more than 4 fishers/sq km of coastal waters. The same information source noted that inequality indicators (Gini coefficients) show there was more equal distribution of monthly average earnings (about 0.22-0.33) in the study bays compared to the country (0.48) as a whole. For example, San Miguel Bay had the least unequal income distribution while Butuan and Gingoog Bays had the highest inequality ratios. Non-cash income from fishing in the form of caught fish ranges from P16.50 for scissor nets to a high of Php172 for gillnets, an incremental benefit of at least 10-20%, leading SuPFA to conclude that it is always better to have fish to eat or bring home rather than not doing anything at all, pointing to the zero opportunity cost of fishery labor.

The aforementioned income data from these two national surveys show that in most bays fishers are only able to meet their family's food needs with little or none left for non-food requirements. The study of Samonte-Tan, White, Tercero, Diviva, Tabara, & Caballes (2007) on the Bohol Marine Triangle reports data on various stakeholders, which allows some comparison among fishers, gleaners, seaweed farmers and tourism business operators. See Table 2.

Table 2: Income profile of coastal and marine resource users, Bohol Marine Triangle, 2004

Variable		Fishers	Gleaners	Seaweed farmers	Tourism business operators
Monthly income from fishing	PhP	4,190.	1,217.	6,014.	16,563.
	US $	78.	23.	111.	307.
Monthly income from other occupation	PhP	2,418.	2,623.	2,974.	143,913.
	US$	45.	49.	55.	2,665.

Source: Samonte-Tan et al. 2007; 1 USD=54 Philippine pesos (2004)

Seaweed farmers earn about 40% more than fishers (PhP 4,190) while gleaners earn even less than a third of the fisher's fishing income. In contrast tourism operators earn almost four times (=PhP 16,563) the fisher's income. Tourist operators earn from a wide range of tourism activities such as scuba diving, whale and dolphin watching, swimming, snorkelling and boating. Monthly incomes from other occupation

are about the same for the first three groups but hit a high of PhP 143,913 for tourism operators. The resorts in Bohol area are among the most visited by tourists and offer a wide range of amenities from modest to luxurious.

What is sometimes overlooked is the dependency of fishers on a diverse range of livelihoods of an opportunistic nature, reliant on seasonal variations, e.g. fishing, farm labor, construction work, carpentry, backyard livestock growing. For example, in Sierra Madre National Park study (Integrated Rural Development of the Philippines, 2002) apart from fishing, six main livelihood activities constitute other sources of income for those interviewed, namely: farming, agro-forestry, carpentry, business, employment and barangay official work.

1.2.2. Access Poverty

Access poverty takes off from a sustainable livelihoods approach (SLA), and measures poverty in terms of deprivation of five different types of assets: human, physical, natural, financial, and social capital. Access to these assets helps reduce vulnerability, keep people out of poverty and serves as a means for the poor to build sustainable and poverty alleviating livelihoods (DFID 2002; McFadyen and Corcoran, 2002).

As in the earlier discussion on income poverty, the following notes on asset poverty reflect the conditions in the fisheries sector because more effort to find data on other types of coastal inhabitants need to be exerted.

1.2.2.1. Natural Capital Assets

This refers to access to land, ecosystem services, and environmental quality.

Fisheries have been described as the last recourse of those who are without resources. Those whose primary occupation is fishing usually do not own agricultural land. Only 40% of fishers surveyed in Fisheries Sector Program (FSP) reported owning the lot on which their dwelling stood while the rest rent or simply occupy other's lots without paying. The open access nature of the coastal and marine areas, its mangroves, coral reefs, rivers, estuaries, and the low financial investment needed to start some form of fish capture activity is a boon for anyone who has no other economic option. Opportunities for livelihood are not as easy in terrestrial inland areas, which require land ownership/tenure or for employment requiring education and skills they often do not have. Because of limited options, they are dependent on resources that are of low value to more endowed dwellers. For example living near the coast carries risks of typhoons, flooding, and eviction due to absence of land ownership (foreshore area is public domain and inalienable).

However as the later sections will show, such access have yielded declining and unstable natural resource services due to the poorer conditions of these resources brought on by human activity as well as by climate change especially extreme weather conditions. The poor's access to these ecosystem opportunities are fragile and vulnerable to any natural biophysical and social changes which can result to their displacement from the resource. For example when these attain value for more powerful groups, as has been the case of mangroves being converted into fishponds by wealthy developers.

1.2.2.2. Physical capital assets

Problems in access to physical capital in the Philippines include water, housing, and infrastructure necessities. Although about 82% own the houses (PRIMEX-ANZDEC Report 1996), these are largely made of light material of *nypa*, bamboo and some wood. About half have sanitary toilets while a substantial percentage use open or closed pits. They have lower access to electricity and safe drinking water.

Poor road links from coastal towns to economic centers have been noted in some of the FSP baseline reports although there is hardly any emphasis to this. Telecommunications infrastructure, transportation facilities and mass media also need to be looked into in characterizing coastal zones and currently are a knowledge gap. Information may be out there but need to be gathered and linked with analysis of coastal

zones. It is most likely that cell phones with its popularly-used texting features have reached even remote coastal areas. But there is a need to ascertain who in coastal zones have access to this utility. The positive impact of infrastructure investments on the welfare of the poor cannot be trivialized. Rural roads and transportation provide access to economic and social services, improve market access, and reduce transaction costs. Access to telecommunications and media provide the residents a sense of "being connected" with the rest of the province/city/nation and the world. It also becomes a source of not only critical information (such as economic) but also of modernizing influence and development to the individual and communities, bringing them out of the physical confines of their *barangays*.

Indeed, there is a need to ascertain the conditions of coastal people as regards to access to physical capital, which in turn influences their access to other resources. Such significantly affects their conditions, and could alleviate poverty situations of those concerned coastal communities. Copes (1990), in explaining why fishers are poor, alluded to the usual condition of the physical isolation of their coastal communities from other human settlements and amenities.

1.2.2.3. Human capital assets

The most important human capital investments in the Philippines are in health and education. The FSP data report that on average fishers have 4 to 6 years of schooling. For example in San Miguel Bay, 56.7% are elementary graduates and in Sogod Bay although the majority of respondents have elementary education only one-half completed the six years program. Comparative data on education (Table 3) of various groups deriving income from coastal and marine resources (Samonte-Tan et al. 2007) show that fishers have the lowest educational attainment (77% are elementary graduate and lower) followed by gleaners (56%- elementary graduate and lower).

Table 3: Educational profile of coastal and marine resource users, Bohol Marine Triangle, 2004

EDUCATION	Fishers	Gleaners	Seaweed farmers	Tourism business operators
% No Education.	0.0	0.0	0.0	0.0
%Elementary Level	26.0	18.8	3.6	0.0
% Elementary Graduate	51.4	37.5	35.7	0.0
%High School Level	11.0	12.5	14.3	0.0
% High School Graduate	7.5	21.9	25.0	10.5
% Vocational	0.7	6.3	7.1	10.5
% College Level	2.7	3.1	7.1	15.8
% College Graduate	0.7	0.0	7.1	63.2

Source: Samonte-Tan, 2007

Seaweed farmers are slightly better with equal percentages reaching elementary and high school levels. In contrast, tourism business operators are mostly college graduates. This mirrors the macro-level characteristic of Philippine education system marked by low cohort survival, declining participation rates, poor quality of education. For every 100 children in the Philippines who start grade 1, only 67 will complete elementary schooling. This rate is even lower for the poor wherein for example in ARMM Region, only 34 of every 100 children who start elementary school only finish. A study done in the Visayas Sea looked at significant factors which predict entry of youth into fishing (Ferrer, Go, & Cainglet 2005). Ferrer et al.'s preliminary results identified these as: being male, household size, distance of house to sea, potable water and the food market, number of years in school, monthly household income. Its recommendations include: bringing elementary and secondary schools closer to barangay residents, undertake developmental IEC campaign targeting young people especially those who reside in the periphery.

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There are few studies that report on the health of residents in coastal areas. Studies undertaken by FAO reveal that contrary to commonly held views, levels of fertility and infant mortality in fishing communities were found to be similar and not much higher than those in farming communities. However, adult mortality rates could be worse than average especially for women. A nutritional study (by Ferrer, 2005) of children in coastal barangays in Guimaras, Philippines showed that the prevalence rate of malnutrition among below-seven-year old children was about 28%. More male children had normal weights than females. There were more overweight males among the overweight members and more females were found among the underweight. The malnutrition status of children in coastal areas may reflect the food status in the households, nutritional knowledge of mothers, and health of mothers during pregnancy. Gender differences in nutrition status of children reflect unequal treatment of sons and daughters in food allocation. It is not clear whether this is true only among coastal households. Ferrer speculates that the belief of males needing to receive a greater share of the food because they do hard work may be strong in coastal communities.

Health should be an important resource that those who engage in heavy physical work such as fishers need. In fact poorer people have to rely more on their bodies for physical work and so their bodies are more likely to be more vulnerable (Macfadyen & Corcoran, 2002). Illness and accidents have greater impact on their poverty.

One can infer then that access to services that preserve and enhance health for the poor and their family should be an important consideration in defining poverty in the coast. For example even if incomes are below threshold, this situation can be alleviated if government health services are adequate and efficient for preventive and some curative health. It is notable that in the Philippines, basic health services are suppose to be freely available at barangay and municipality health centers although there is a bias for urban centers among health professionals. Private health care would be prohibitive for cash-strapped households. Data on the extent to which delivery of health services to coastal communities is available and utilized need to be put together from existing health documents. Likewise gender-sensitive mortality and morbidity rates and patterns in the coastal population would be needed to identify client-responsive approaches to health care.

1.2.2.4. Financial capital assets

Another form of access poverty is the inability to take out credit from lending institutions. Due to the poverty conditions of most fishers, access to cash for capital expenditures such as craft repair and gear replacement as well as other household needs are extremely limited. Their ability to generate savings is seriously hampered by the unpredictable income patterns in fishing. Although in the Philippines the level of remittances from Overseas Filipino Workers (OFW) is phenomenal and provides cash to workers' families left in the country, there is no data on the participation of fishers and other coastal residents in this remittance economy.

One FAO microenterprise project undertaken in the Philippines involved credit to women in fishing communities and demonstrated that incomes are improved for the household (Tietze & Villareal). Some women reinvested their profits to purchase a traditional fishing *banca*, motorboats and fishing nets. The ownership of these assets also enabled the women to have a steadier supply and bigger quantity of fish to sell. The repayment of loans was also commendable, given the past history of dismal repayment of credit in many government programs. Lending to women, who happen to usually be the target clients in fishing communities because of their better repayment records, has also led to their empowerment.

However we need to know the level of availability, use and impact on poverty of microfinance schemes within coastal communities and what problems are encountered.

1.2.2.5. Social capital assets

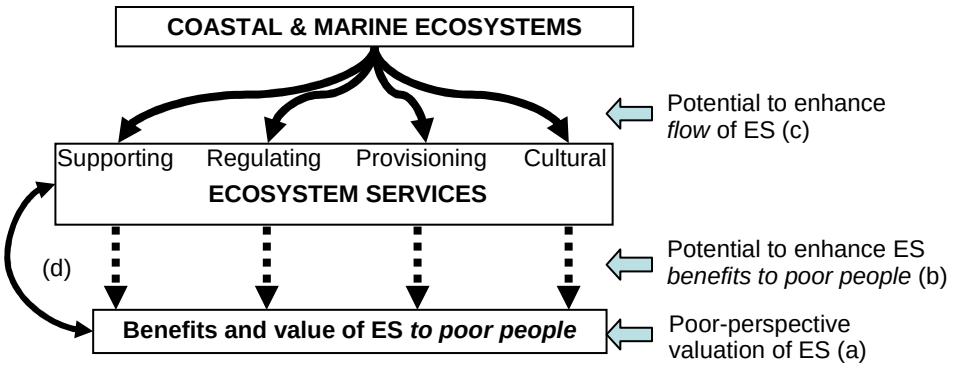
Social capital comprises the social resources on which people are able to draw, through networks and connectedness and relationships of trust and reciprocity (Schelzig, 2005). Social capital is the foundation for informal safety nets among the poor. The large family sizes characteristic of Filipino families (averaging 5 to 7 members,) which is also true of respondents from coastal communities, actually function as social capital for the poor. Larger households are more protected from shortfalls in consumption due to economies of scale and more diversified income sources (Madfadyen & Corcoran, 2002; Goh et al. 2001). Other studies have contrary findings, that exit from poverty is slower for larger households (Baulch and McCulloch 1998; Macfadyen & Corcoran, 2002).

One way to foster social capital in coastal communities is to actively effect the organization and mobilization of Fisheries Aquatic Resource Management Councils (FARMC) which can encourage collective action towards effective resource management but also increase social interaction in the community. Cohesiveness is strengthened and empowerment of stakeholders leads to liberating action toward working for their own welfare, thus decreasing dependency on external agencies. The formation of such councils at the *barangay* and municipal levels has however been lethargic, despite the mandate having been issued in the 1998 Fisheries Code.

1.3. Project Conceptual Framework

This study will form as an integrated part of the Southeast Asian regional scale analyses that will extend the framework in order to identify and elaborate the key challenges facing coastal and marine ecosystems which are most likely to threaten their ability to support livelihoods and provide benefits to human populations in regions with high levels of poverty, high dependence on marine and coastal resources, from a diverse range of ecosystems. The research conceptual framework is presented below in Figure 1, which shows how coastal and marine ecosystems provide a range of ecosystem services – classified as supporting, regulating, provisioning and cultural – which in turn may bring benefits to poor people.

Figure 4: Linking Ecosystem Services and Poverty Alleviation



Interventions may potentially enhance the flow of ecosystem services, to enhance the benefits specifically for the poor, or to add value for the poor. In turn capturing values of ecosystem services may affect the way people manage ecosystems and hence their potential to deliver services.

2. ECOSYSTEM SERVICES AND LINKAGE TO POVERTY ALLEVIATION

2.1. Coral reefs

2.1.1. Provisioning ecosystem service of coral reefs

2.1.1.1. Assessment of national information sources

In the literature, the most frequently cited ecosystem service of coral reefs is its provisioning function. Almost all readings relate reefs with its provisioning of food and animal protein in the diet and its being a

major livelihood and income source of coastal residents not only for fish but also for incomes from tourism potential of reefs. It also provides curios and ornamentals for the aquarium trade and is a source of construction materials.

Although reefs are also known for being a source of pharmaceutical compounds, information on the dynamics of such provisioning in the Philippine setting is only recently being explored in the Philippines. The UP Marine Science Institute is currently engaged in a comprehensive "PharmaSeas" Drug Discovery Program which include mapping out areas in the country which are considered as rich "biogeographic regions" (Salazar 2008). The PharmaSeas team dive up to 80 feet down to specific coral beds delineated every 50 meters. The program hope to uncover microrganisms in coral beds which may eventually yield anti-pain and anti-infective compounds needed to treat diseases that are becoming resistant to current medicines.

2.1.1.2. Trend/change dynamics

The first demonstration of the positive effects of well-managed fish sanctuaries on coral reefs and its related fisheries was the Sumilon Island Fish Sanctuary established in 1974. For a period of ten years a portion of the island was closed to all fishing. As a result, a) living coral cover more than doubled to about 60 percent, b) fish abundance more than tripled with the most significant increase among those fish targeted by fishers, and c) yearly fish catch on the reef, but not in the sanctuary, increased from 14 tons per sq km to almost 36 tons per square km. (White, Salamanca & Courtney 2002). This demonstrates the spill-over effects of a well-enforced no-take zone.

The Gilutongan Marine Sanctuary in Cebu, Philippines is reported to be well-enforced and has led to significant and rapid improvements of the site's environmental conditions: increases in both live coral cover and fish populations, size and abundance of larger, "target species" of fish (Ross, Ross, Green, Amores, Carina & Menguito 2002). Their Reef Check data cite average fish catch outside the MPA increasing significantly to about 2kg of fish per hour compared to pre-MPA surveys of 2 kg/day. Quality and size of fish were also observed to increase.

Similar improvements are documented in the fish sanctuary and marine reserve established in San Salvador Island in Zambales where live coral cover showed a 10 year increase (1988-1998) from 23% to 57% average for the island and 26% to 55 % average for the sanctuary area (White, Salamanca & Courtney 2002). During the same period, fish density increased from 322 per 500 sq m to 1199 per 500 sq m. Fish yield increased from 7 tons/sq km/yr in 1988 to 14 tons/sq km/yr in 1991. The increases in fish yield and fish density may be attributed partly to improvement in live coral cover.

Mixed results were found in two Bohol Islands (Christie, White and Deguit, 2002). Living hard coral cover increased from 20-46% in Balicasag's sanctuary and 19 to 30% in non sanctuary (1984-1999). Living soft coral cover decreased slightly in Balicasag sanctuary and increased significantly in non-sanctuary. In Pamilacan Island, living hard coral remained constant from 10 to 8% in the fish sanctuary and decreased slightly in the non- sanctuary area. Living soft coral fluctuated between 3 and 10% in their sanctuary and decreased from 28-14% in non- sanctuary.

The establishment of marine reserve areas in 15% of municipal waters is a legal mandate enshrined in the Fisheries Code. However implementation and enforcement have not been as forthcoming. In fact a critical finding in the review of active MPA's is that, in order to realize the expected benefits from sanctuaries there need to be a network of MPA's, rather than isolated geographically scattered sanctuaries. This is because intensive fishing effort adjacent to no-take areas can negate the fish abundance generated by MPA. "Thus San Salvador Island Sanctuary is not as sustainable as has been portrayed since 1990. It is facing some serious threats that will require broader area management to address through the multiple municipal management body for the Protected Seascape." Christie et al (2002)

The aforementioned recommendation is echoed in the BFAR SuPFA Report (2006) which expressed the opinion that "the deployment of fish sanctuaries is essential, but not sufficient to ensure sustainability of Philippine coastal fisheries." Large areas are needed to be set aside as sanctuaries in order to sustain reefal demersal fisheries in the country and that perhaps it is cheaper to reduce fishing effort than to undertake the costs entailed in protecting large no-take areas. Illegal fishing continues, even in areas with MPA's because enforcement (even community-based) is also difficult to sustain and the economic

demand for reef products is high. A lucrative export market leads to an intensification of production, controlled by players and forces outside the local environment.

The scale of coral reef degradation in the country is not limited to the aforementioned effects of human activities – e.g. overexploitation, market demand, illegal fishing. Natural causes such as coral bleaching (associated with temperature changes and coral diseases) and damage due to tropical storms account for some portion of coral reef degradation. Evidence of this are the impact of El Nino and La Nina phenomena during the past two decades and the occurrence of Crown-of-thorn outbreaks which may be expected to increase due to global climate change. One study found that a significant portion of the hard corals on Balicasag was killed by the 1998 bleaching event (Christie et al (2002).

2.1.1.3. Links with poverty alleviation

The coral ecosystem provides employment and supports local economy especially for municipal fishers who are 78% of resource users, in the case of the Bohol Marine Triangle (Samonte-Tan et al., 2007). The open access nature of reef fishing makes it accessible to landless poor as a major occupation or as a safety net when other income sources fail. Ironically, this open access characteristic also drives overfishing, such that the incomes derived by municipal fishers have generally diminished to below poverty threshold levels.

However continued benefits depend on the ability of stakeholders to maintain the diversity, health and productivity of ecosystem. The biophysical benefits from well managed MPA's improve the catch of fishers although studies do not indicate whether this improvement allows them to breach the poverty threshold. The studies report increases in fish catch after MPA's have been set up but stop short of investigating how the increases convert to actual income improvement and household welfare. When a community-based participatory process is used to establish MPA's, such as is utilized under the cover of coastal resource management, there are gains in terms of social capital - leadership development, sense of empowerment and involvement- but silent on gains in terms of income and increased access to human, physical, capital, and financial capital.

There is a divide between studies done by marine and fisheries scientists and those by fisheries social scientists. While the former focus on marine/aquatic organisms and biophysical and habitat changes to the exclusion of effects on people and communities, the latter focus on human behaviour and interactions with scant recognition of the influence exerted by relevant ecological factors.

Some readings have specific recognition that small scale fishers are less able to cope with declines in coastal resources or restriction to fishing effort (Stobutzki, et al. 2006). This has increased coastal poverty resulting in their children being malnourished, prone to disease, and unable to complete their schooling (Ferrer, 1996). No studies were encountered on how coastal folks cope with declines in reefs productivity, such as its effects on migration patterns of family members and on fertility and population growth in these communities.

Women and children are better able to participate in coral reef fishery unlike in most other types of capture activities due to the diversity of options for exploitation and the physical accessibility of the reef (Campbell and Beardmore, 2001). The study of Del Norte et al. (1989) observed that women and children commonly gather bivalves, crustaceans, seaweeds, gastropods, sea cucumbers, and octopus on the exposed reef flat areas during low tides in Bolinao, Pangasinan. This shell gathering provides food for the table as well as some minimum of income for the womenfolk in the barangay. It is therefore also the women who are most disadvantaged when coral reefs, mangrove areas and mudflats are included as no-take-zone protected areas, and when disasters such as oil spills damage these habitats.

The establishment of fish sanctuaries and marine protected areas has become more widespread although the implementation and enforcement needed to sustain them still pose a major challenge to stakeholder communities and local governments. A critical lesson drawn from various documentations on MPA's is of that the strong degree of involvement from the community is essential for sustainable reef management (White et al. 2005). In the San Salvador experience, the post-project perception studies reveal higher perceived levels of knowledge of fisheries, better information exchange, satisfaction with fishery arrangements, benefits from marine reserve, and quickness of resolving community conflicts. There is also noted several positive changes in perceptions between pre and post project responses,

although lower positive gains were found on participation in general community affairs and in fisheries management.

When tourism potentials of reefs are recognized and developed, fishers can find an additional source of income and can even explore shifts in occupation. Strategies to decrease fishing pressure like closed season and limiting number of fishers can then become more feasible. Entire households can participate in the tourism economy, through various services they can provide (boating, resort employment) and crafts that they can create and vend. In Gilutongan, vendors are allowed to work at the MPA on rotational basis and play a role in day-time enforcement. Minor services, mainly vending, are provided by locals. (Ross et al. 2002). MPA revenues are also shared with the barangay which enable small infrastructure and social projects for the community.

2.1.1.4. Tradeoffs

There are many who draw livelihood from the coral reefs and these stakeholders recognize their equal rights to this benefit. However conflicts are recognized between fishers with destructive operations and law-abiding fishers. Although local fishers blame migrant fishers for perpetrating blast and cyanide fishing, locals themselves are involved in prepare blasting devices from readily available materials. There appears to be little appreciation of the utility of reefs, as well as other ecosystems, to future generations, although no published data was found to support this.

Not all biophysical changes are viewed as positive by all stakeholders. Fishers may be concerned mainly in improving environment in order to realize better fish yields which may be a different view from that held by a pure environmentalist. Establishment of sanctuaries creates the perception that fishers are being deprived of their right to fish in their natural fishing ground. (Adan, 2004)

Reduction of fishing effort will require provision of opportunities for alternative livelihoods for the poor. In Tubbataha, the claim of traditional rights in the park need to be addressed by providing more livelihoods projects to the community affected and the preferential access to resources in the buffer area of the park. In Malalison Island the use of artificial reefs provided employment and business opportunities for the community through demand for gravel and sand and services (Agbayani and Siar, 1994). In Magsaysay, Misamis Oriental sanctuary establishment led to projects for those displaced and later the community as well, such as seaweed farming, livestock dispersal, contour farming (Adan 2004).

Destruction of coral reefs from blast fishing over a 20-year period is estimated to result in net losses to Philippine society of 1.17B dollars which far exceeds the individuals' short term gains from the activity (Burke et al. 2002). The same type of pattern is found for other illegal fishing activities. Moreover, even if coral reefs are only partially destroyed these do not quickly return to high levels of productivity. It can take about 50 years to regain 50% of their original coral cover and productivity. Raymundo (2007) experimented in Calagcalag Island on an approach to rehabilitate blasted reefs and re-establish habitat. The study demonstrated some success in improving coral cover and re-establishing habitat within two years.

2.1.2. Cultural Ecosystem services of Coral Reefs

2.1.2.1. Assessment of national information sources

The second most frequently studied service provided by coral reefs is cultural, which covers the aesthetic, spiritual, educational and recreational aspects. The knowledge provided comes mainly from several studies on marine protected areas which actually do not directly address the culture aspect as they do the biophysical and provisioning function. The other source comes from the increasing popularity of resource valuation studies which try to estimate economic value of, among others, cultural benefits derived from ecosystems. The value of coral reefs to tourism has provided an important alternative to its exploitation for reef fish. The beauty and diversity in coral reefs is the foundation of a thriving and valuable dive tourism industry. While tourism potential of coral reef areas has made them economically valuable, their cultural value for those who live in proximity has not been given much attention. This should especially be so for the poor coastal dwellers who have little resources to visit appropriate places for recreation and spiritual rejuvenation.

Although reefs have been shown to draw students and researchers to investigate its biophysical complexities, explore its opportunities for bio-prospecting, and its psychological and aesthetic contribution to human well-being, these have not been addressed in the literature on the Philippines.

2.1.2.2. Trend/change dynamics

The following trends are observed and some are captured in the literature on coral reefs and coastal resource management. Since the discovery that ecotourism makes good business sense, there has been an increase in the number of thriving enterprises that locate in reef-based areas and enable tourists to enjoy activities such as diving, snorkeling, dolphin/whale watching, bird-watching, scenic picnic grounds. MPA's are a feature of ecotourism which can provide these opportunities. Preservation and rehabilitation of coral reefs continue to generate national and international interest and cooperation. For example, Tubbataha Reef is a World Heritage Site and currently is a strong contender for a place in the New Seven Wonders of the World. The beauty of healthy reefs is a source of pride and enjoyment to local and foreign tourists (White et al. 2002). International agencies like USAID and ADB provide loans and/or grants to undertake reef-conservation related project.

In terms of the educational opportunities provided by reefs to study habitats and its biophysical aspects, the driving necessity is for the development and maximal use of biophysical measures for establishing baseline, monitoring and managing reef habitat conditions (Olsen et al. 2005). On the other hand, the need for reef management provides educational and training opportunities for community to positively influence enforcement (Raymundo et al. 2007). Stakeholder involvement in reef management builds social cohesion (Ross 2002).

The continuing degradation of marine resources and multiple use conflicts have led international agencies to initiate the development of integrated oceans policy which aims to promote harmony and maritime security (Cicin-Sain, Kuribayashi, Mathias, et al. 2006).

2.1.2.3. Links with poverty alleviation

Tourism stimulates the provisioning service of coral reefs through revenue from tourists, which can be double that coming from fishing (Christie et al. 2002). The cultural service is captured in the growing awareness, appreciation and hopefully vigilance by Filipinos on the natural environment and conservation issues. This is demonstrated in reported willingness of tourists to pay to enter and view no-take zones and to maintain anchor buoys. The poor in the coastal communities demonstrate their stake in the environment by themselves advocating conservation, realizing that tourists are just passing through while they will have to live with the environment that can potentially be damaged by tourism. Thus the "invasion" by tourists should stimulate advocacy and protectiveness on the part of the coastal poor for the preservation of their environment from tourism-related excesses.

The cultural value to the poor of the reefs ecosystem, apart from its provisioning of food and incomes, need to be studied. To what extent are they aware of the links between reefs and the well-being of coasts and the marine habitat? What is the psychological effect on them of their proximity to reefs and the habitats that breed coveted aquarium fish? Are they able to enjoy the snorkelling and diving which wealthier tourists are willing to pay substantial sums for? Does this kind of habitat connect them to their aesthetic and spiritual side? These are questions for which studies are not yet available.

Coastal folks who live in the vicinity of reefs have a more intimate knowledge of this environment and provide a resource to society with their indigenous knowledge. If society recognizes this contribution, the poor who possess this knowledge have gained human and social capital, which is a form of poverty alleviation. While no study seems to have addressed this, this kind of framework may be investigated in future work.

2.1.2.4. Trade-offs

There is the implied conflict between the coastal folks who have traditionally used the coasts and the new entrants represented by paying tourists, resort owners and related businesses. Whose right to use the coast for recreational, aesthetic and spiritual benefit is primary? With the entry of divers, snorkelers and boating tourists, locals have now to pay more for most related services.

The conflicts between fishers and divers in reef areas: Divers may seem to have appropriated the areas around reefs and have marginalized traditional fishers. The joint use of this two groups are not compatible and fishers are likely to be the less powerful group.

Marine reserves are at the heart of much of the recreational value of ecotourism and, when properly managed, have been shown to positively impact fish abundance, biomass and species diversity through habitat preservation with notable spill-over effects in areas outside the reserve. However for households that rely on fishing related income sources, even given social preparation prior to MPA establishment, marine reserves still represent limitation of their fishing grounds and seen as a threat to their survival while catering to the less basic need of visitors. The concern for sustainable alternative livelihoods continues to be a strong challenge.

The strong government-led (Department of Tourism) campaign to increase international tourist arrivals has resulted in the aggressive development and expansion of island resorts by private sector. The danger of overexpansion beyond the limits of islands is feared. A fitting illustration is Boracay Island which has been pressed beyond its ecological capacity as indicated by high coliform count in the beach, inadequate sewage system, mushrooming of hotels and restaurants with poor enforcement of land use and building requirements. This has resulted to overabstraction of water, contamination through poor sanitation and leaching from solid waste.

These environmental impacts are often not clearly visible until their cumulative effects have destroyed or severely degraded the natural resources which attracted tourists in the first place. For some destinations the costs of environmental damage are only recognized after significant and often irreversible damage have occurred (MA synthesis).

2.1.3. Supporting Ecosystem of Coral reefs

2.1.3.1 Assessment of national information sources

Although coral reefs occur mainly in relatively nutrient-poor waters of the tropics, they have high productivity because of efficient nutrient cycling on reefs and complex predator-prey interactions maintaining diversity. However, reefs are prone to overexploitation due to the low conversion of primary productivity to higher levels as a function of a high number of trophic levels. (MA :Ecosystems and human well-being).

Reefs support and improve biodiversity, such as through gene resources and diversity, larval dispersal and general support for ecological processes. Reefs contribute to the formation of beaches through coral erosion. Overfishing, destructive fishing practices, habitat loss, pollution, and other human impacts have resulted in the destruction and modification of coastal habitats around the world. These in turn have reduced the ability of reefs to provide their services and threatening biodiversity. Because coastal habitats are tightly interlinked, the loss of one habitat degrades and reduce the services provided by linked habitats.

2.1.3.2 Trend/change dynamics

Due to the aforementioned trend of destruction of coral reefs and of corresponding habitat degradation, the supporting service of corals in terms of biodiversity conservation is expected to decrease. Pollution that comes from various anthropogenic sources including industrialization, urbanization, aquaculture, etc. are also expected to affect corals' supporting capability for breeding and spawning of many pelagic fish species and safe havens for juvenile fishes seeking refuge from open ocean predators.

A study on biogeochemical processes in Lingayen Gulf and its associated catchments and socio-economic drivers (LOICZ, 2000) takes particular note of the issue of waste loading into Lingayen Gulf. The waste load of N and P were estimated from relevant economic activities in the Gulf, including household activities, urban run-off, agriculture run-off, livestock, aquaculture. The analysis of the data drawn from primary and secondary sources indicate that the gulf is impacted mostly by waste from agriculture and household activities and remains vulnerable to unregulated dumping of sediments and

nutrients through surface runoff or groundwater seepage. Moreover, the negative impact is most dramatic on nearshore environs such as embayments, channels and along river mouths, and get increasingly diluted as one proceeds away from shore. Readers can speculate on the degree of impact on coral reef habitats; however what is clear is that pollution will affect coral nearer shore than farther.

2.1.3.3. Links with poverty alleviation

The literature reviewed makes no direct mention of supporting service in relation to poverty issues.

2.1.3.4. Trade-offs

The literature reviewed makes no direct mention of trade-offs from supporting service.

2.1.4 Regulating Ecosystem services of Coral Reefs

2.1.4.1 Assessment of national information sources

Reefs provide coastal protection by buffering land from waves, currents and storms and prevent beach erosion. Thus coastal communities living in the shelter of coral reefs receive such protection. Reefs likewise play an important role on nutrient fertility and cycling, and provides atmospheric and climate regulation.

2.1.4.2 Trend/change dynamics

In the absence of uncovered studies touching on these regulation functions in Philippine habitats, one can speculate that these ecological services of corals are on the decline because of the decline in live coral cover.

2.1.4.3. Links with poverty alleviation

The literature reviewed makes no direct mention of supporting service in relation to poverty issues.

2.1.4.4. Trade-offs

The literature reviewed makes no direct mention of trade-offs from supporting service.

2.1.5 Key Knowledge Gaps in Coral Reefs

Economic valuation of natural resources has gained currency; however the values for non-material benefits should be examined in terms of their validity in capturing the true importance to human well-being. For example, what value can be put on culture services provided by ecosystems? In the same train of thought, there is no recognition of the non-material indicators of poverty/well-being within the literature on ecosystem services. The cited links to poverty are chiefly monetary income from increased catch and tourism services. However there is scant discussion of the impact of interventions on health, nutrition, education, social networks and relationships. This absence reflects the narrow view that poverty alleviation can be handled simply by increasing incomes.

Even when incomes are used as the major measure of poverty levels, there is no targeting being done to enable fishers to breach the poverty threshold. Differences in income levels from pre and post project interventions are reported, but what this means in terms of quality of life for the fishing household is not measured or even speculated on.

The net benefits coming from rich and diverse ecosystems need to inform decision making of local government, so that conservation strategies stand a chance against competing projects with straightforward business and economic profits. However resource valuation methodology is still in the

hand of a few elite academics and economists. There is low awareness and ability to maximize use of biophysical information in resource management

Despite what is known about community mobilization and organizing, the dynamic interaction of factors that influence high involvement of local communities and LGU's in planning and enforcement, as well as ensuring sustainability of desirable processes beyond project live and leader change are complex. Related to this is the need to identify how to establish institutional memory and an information and capability building system, which is rarely achieved in a politically driven governance system (White, Eisma-Osoriob, Green).

Among the extensive sources of information on coral reefs is the experience of the Fisheries Sector Program (FSP), which unfortunately had inadequate set of resource baseline information upon which evaluation and management decisions could be based. The challenge for methodology for establishing comparable data bases remains to be addressed in order to have a better basis for concluding project success with greater scientific rigor and for identifying appropriate interventions, especially in targeting poverty alleviation.

There is also a need to develop methodology for scaling up ICM programs from small locales and nos. of stakeholders toward broader and more effective coastal area management. This call for methodology applies as well to creating networks of marine protected areas.

Critical factors for effective enforcement of MPA/s which will capture the involvement of fisherfolks and increase the benefits to poor fishers have to be identified. This will need experimentation on strategies to increase the current small range of economic incentive packages to complement good coastal mgmt. The schemes that have been tried don't often employ people to the extent required to relieve human dependence on depleting coastal resources.

Demographic research on coastal communities is needed to capture the dynamics connecting population growth and depletion/sustainability of coastal resources.

How to optimally undertake fruitful interdisciplinarity in ecological systems cum poverty research, avoiding the trend in the past where natural scientists focus only on the biophysical to the exclusion of the social science aspects and vice versa. Similarly some CRM studies look only at governance issues and ignore the biophysical indicators, when both need to be interrelated to optimize learning and sharpen analysis.

Although coral reefs are exceptional reservoirs of natural bioactive products, we have not encountered studies on this in the Philippines. It is likely that such studies form part of R&D of wealthy pharmaceutical companies which are confidential in nature and thus not open to public scrutiny. Thus the contribution of this facet to poverty alleviation or exacerbation is unknown.

Studies on the spiritual and ceremonial significance of the seas and coastal ecosystems to Filipinos have not found its way into the literature in the past couple of decades. The cultural value for those who live in proximity has not been given much attention. This should especially be so for the poor coastal dwellers who have little resources to visit appropriate places for recreation and spiritual rejuvenation.

Although reefs have been shown to draw students and researchers to investigate its biophysical complexities, explore its opportunities for bioprospecting, and its psychological and aesthetic contribution to human well-being, these have not been addressed in the literature on the Philippines.

To what extent are inhabitants of the coast aware of the links between reefs and the well-being of coasts and the marine habitat? What is the psychological effect on them of their proximity to reefs and the habitats that breed coveted aquarium fish? Are they able to enjoy the snorkelling and diving which wealthier tourists are willing to pay substantial sums for? Does this kind of habitat connect them to their aesthetic and spiritual side? These are questions for which studies are not yet available but will enrich our understanding of coastal dwellers and the significance (or lack of it) to them in their assessment of reefs and related habitats.

Coastal folks who live in the vicinity of reefs have a more intimate knowledge of this environment and provide a resource to society with their indigenous knowledge. If society recognizes this contribution, the poor who possess this knowledge have gained human and social capital, which is a form of poverty

alleviation. While no study seems to have addressed this, this kind of framework may be investigated in future work.

An increasing number of studies are highlighting the inherent vulnerability of marine species to overexploitation. Particularly susceptible species tend to be both valuable and relatively easy to catch as well as having relatively slow population production rates. Thus species such as large groupers and some sharks are particularly vulnerable.

2.2. Mangroves

2.2.1. Provisioning ES of Mangroves

2.2.1.1. Assessment of national information sources

There is a wide range of environmental goods and services provided by mangrove ecosystems, among these are, "food and beverages which include fish, crustaceans, shellfish, sea cucumbers, other invertebrates, wildlife, honey, condiments, vegetables, tea substitutes, sugar, alcohol, cooking oil, vinegar and fermented drinks" (IUCN, 1983; Fisilier, 1990; James, 1991a & b; Ruitenbeek,1992; Groombridge, 1992; and Hirsch and Mauser, 1992; as cited in Gilbert and Jannsen, 1997). The fisheries products from mangroves provides food and income, among these are crustaceans and bivalve molluscs such as the clam *Anodontia edentula*, locally known as *imbao*. This fish food commands a high price (P1.50 to P5 peso per piece in Guimaras and Iloilo) in local markets and is reputed to have aphrodisiac properties, however their harvested sizes and number are on the decline (Primavera, et al, 2002), which might be indicative of pressures on the associated ecosystems.

Moreover, traditional medicines may also be derived from (plant, fungal, etc.) mangrove-associated species, while fodder for livestock during the dry season is also provided by mangroves. Mangrove ecosystems also supply raw materials such as wood, leaves, *Nipa* shingles and tannins, which are used in building and construction. Tannins are also used in the manufacture of textiles for clothing and household fabrics (IUCN, 1983; Fisilier, 1990; James, 1991a & b; Ruitenbeek,1992; Groombridge, 1992; and Hirsch and Mauser, 1992; as cited in Gilbert and Jannsen, 1997). It can be noted that these traditional medicines and other products which are usually extracted by coastal people (who are in many cases poor households) has provided them cheaper alternatives than when they purchase those commercially supplied by shops or stores.

In Banacon Island, Bohol, Walters (2000, 2004) recorded that residents of 550 households have always depended on the harvest of mangrove wood to meet most domestic fuel and construction needs. As well, since the late 1950s they have planted trees so that vast expanses of formerly natural forest are dominated today by monocultures of relatively young planted Rhizophora stylosa".

The same sources/authors above also attribute to mangroves the various raw materials for industrial purposes, such as timber and pulp/chipwood from commercial forestry operations and products from plantations of *Nipa fruticans* which is used to make alcohol for biochemical industries. Mangroves supply fuel and energy products in firewood and the manufacture of charcoal (also cited in Primavera, et al, 2005). Melana et al (2000) also cited firewood and charcoal, and added poles for fish traps, among the various products/ goods derived from mangroves.

In various part of the country, fish fry (collected in Currimao in Ilocos Norte, Puerto Princesa in Palawan, Pandan in Antique, Jagna in Bohol according to Ahmed, at al, 2001), juvenile fish and shellfish suitable for (aqua) cultivation may be captured in mangrove ecosystems and on shores near mangroves. Corollary to this, Melana et al (2000) argued that aquaculture and fisheries depend on mangrove for juvenile and mature fish species". The high production and export of organic matter from mangrove forest, along with the physical habitat structure they have are among the conditions that make them important nursing ground for many coastal fish and invertebrate species.

Furthermore, mangrove propagules may be collected, reared in nurseries then transplanted in (government-sponsored) reforestation and afforestation programmes. Additionally, feathers and flowers, which serves as ornamental resources, may also be derived from mangrove ecosystems.

Fernandez, Subade and Parreno (2005) estimated a 20-year net present value of 42 million pesos from the 14.4-hectares of mangrove reforestation projects in Sibunag, Guimaras which also incorporated coastal protection and conservation or non use values. The NPV estimation allowed for sustainable harvesting, of products which are mangroves P-ES, such as: medicines for stomach ache and cough, roots for aquarium trade, dye, fodder for animals, wood for some furniture, etc. In an annual per hectare basis, the NPV translates to P145,833 (or US$2,916) per hectare per year.

2.2.1.2. Trend/change dynamics

Alongside the decline in mangrove hectarage is the associated reduction in the provisioning ES of such coastal ecosystem, particularly food provisioning. It can be said that a huge portion of mangrove areas converted to fishponds could have partially off-set the reduced provisioning ES through the volume of farmed fish. Harvested milkfish, prawn, crabs and other species from fish farms converted from mangroves, have amounted to several tons of fish and millions of pesos. However, further studies on this trade off could shed light on the comparative provisioning benefits that could be derived from the two options.

Melana et al (2000) explains that, "government policies, which dictated development in both the uplands and coastal areas, have been based mainly on abundant available resources without due consideration for sustainable options for future generations. In the 1950's, vast tracts of mangroves were awarded to concessionaires and logged over for firewood and tanbarks. Mangrove firewood was the preferred fuel source in coastal villages and most bakeries because of its high heating value, but a greater volume was exported to Japan as firewood, which reportedly became the source of rayon. In the 1960's, the government adopted a policy aimed at increasing fish production by converting large areas of mangroves into fishponds for the culture of milkfish (Chanos chanos) and prawns. Such policy was promoted by a government program, which classified and released mangrove timberland for fishpond development and opened loan windows in most government banks to finance fishpond development".

They further noted that, "It was only towards the end of the 1970's when the government realized the fishery value of mangroves. A National Mangrove Committee was formed in the then Ministry of Natural Resources, and a Mangrove Forest Research Center was created under the Forest Research Institute of the Philippines. The former was charged with the formulation of policies/recommendations for the conservation and sustainable management of the remaining mangrove forests in the country, while the latter worked for the generation of technology for the rehabilitation, production and sustainable management of mangroves. Not surprisingly, this "decade of awakening" was also significantly marked with an alarming decline in fish catch. The government then opened loans to fisher folks for the purchase of motorized boats and improved fishing gears. The program ended with most fishers unable to pay back their loans as their fish harvests and incomes continued to decline."

2.2.1.3. Links with poverty alleviation

As mentioned earlier, mangroves provide wide range of goods and services, most of which have benefited rural coastal poor, particularly the fry gatherers in various parts of the country like Antique, Palawan and Sarangani (Ahmed, et al, 2001), and the aquaculture-dependent coastal households of selected *barangays* covered by the study of Irz, et al (2006).

Many of the reviewed materials on mangroves mentioned or cited mostly provisioning ES benefits from them or from their ecosystems thereby contributing to the human well being (Samonte-Tan, et al2006; Walton et al, 2006; Padilla and Jansen, 1996; Gilbert and Janssen, 1997). The latter linkage, however, is not always indicated in the discussions, and in many cases was just implied. Furthermore, it is only in few instances that such provisioning was linked to the attainment of human well being or alleviation of poverty of specific group or community concerned, one of which is in the research by Irz, et al (2006), whereby fishponds provided free non-farmed fish species to the families of hired labor in at least three coastal barangays covered by the survey. Pomeroy & Katon (1998) found that most of the families in the three coastal *barangays* of Cogtong Bay, Mabini, Bohol gathered crabs, shellfish, algae and other marine products "for subsistence", indicative of or implying their low income or poverty.

Walton et al, (2006) found that community led mangrove reforestation areas in Aklan could provide fisheries, tourism and timber benefits amounting to US$315/ha per year, aside from other non-tangible

benefits, however no reference was made on how much or whether part (or all) of the benefits would go to the poor. Thus, while several of the available literature shows provision of ES to people and hence to human welfare, few indicated linkages between mangroves' P-ES and poverty alleviation.

2.2.1.4. Trade-offs

A major concern that has emerged for Philippine coastal management is one of making trade-offs between ecosystem services or uses in the allocation of the country's increasingly scarce resources among various members and sectors of society. It is understandable that as one of the commons, mangrove ecosystem can just end up in the dire "tragedy of the commons" situation discussed by Hardin (1968). As what has happened in various common resource, since no one owns it (mangrove resource/ ecosystem), everyone will be encouraged to just use and harvest as much from such commons, until it is decimated or over-exploited. No one will care to conserve and sustain is, demonstrating the subtractibility of various ES, if nothing is done to conserve it.

Moreover, other human activities like household production (that uses mangrove products like charcoal ad firewood) of coastal human settlements, industrial development and oil deliveries can threaten and impinge on mangroves.

A dominant trade-off between ES has been one on aquaculture vs. mangrove stand, as already mentioned above (Jannsen and Padilla, 1996; Gilbert and Janssen, 1997). This is a trade-off from one form of provisioning ES to another. Janssen and Padilla (1997) used multi-criteria analysis to determine what should be the choice in the trade off, and they found that, "if efficiency is maximized, semi-intensive aquaculture is the preferred alternative; if equity and environment are also considered important policy objectives, commercial forestry is the best alternative.

With respect to time horizon, the short term goals to address employment, economic growth and food security generated costly implications in the long term, i.e. positing a trade off on the long term goal of sustainable development. In particular, as also explained by Melana, et al (2000) the government policy in the 1950s to 1970s of increased food (and fish) production encouraged the conversion of vast mangrove areas to fishponds. However, it was not a guarantee that the new land use will give higher output of provisioning ES, since various goods and services from provisioning ES are cancelled out due to the new fish farming usage of the former mangrove areas. The trade off then becomes: "high yield or production of farmed fish species (milkfish and/or prawn in most cases) at the expense of various mangrove products like tannins, charcoal, crabs, fry, clams, fish, etc."

Another associated trade off is not only in terms of mangroves' ES but importantly between two user groups, the rich and the poor. Many people thought that the fishpond lease agreement (FLA) have been enjoyed mostly by the fewer rich (and middle class) families who got the connections, the time and money to invest in fish farming. The FLA conversion of mangroves, however, meant that the nearby shorelines for small scale fishing and fry gathering (that benefits artisanal fishers) would become less productive due to the effluent discharges coming from the used water flushed out from the brackish water ponds. To date, there is no documented case of men-women user conflicts on the provisioning services of mangroves, nor has there been ethnic conflict written about in mangrove ES availability.

2.2.2. Cultural ES of Mangroves

2.2.2.1. Assessment of national information sources

Cultural ecosystem services refer to the non-material benefits people obtain from ecosystem through spiritual enrichment, cognitive development, recreation, reflection, and aesthetic experiences. Much of the cultural ecosystem services of mangroves have been sought for and availed by people through tourism, eco-tourism or coastal recreation and cognitive development or educational/research purposes. However, only in few instances that the literature explicitly discussed that the poor people availed of such cultural ecosystem services, either directly (as the ones enjoying the cultural ecosystem services or indirectly through the livelihoods and income generated by eco-tourism/ coastal tourism that made cultural ecosystem services accessed/ enjoyed by other non-poor groups (both domestic and foreign).

The geographical coverage of sources covered was varied and across the country, though many of the sources did not explicitly indicate mangroves as the source of such C-ES. In several instances, for literature that mentioned MPAs as the ecosystem dealt with, it was assumed that there were mangroves in such MPA.

2.2.2.2. Trend/change dynamics

An evolving reality is the increasing awareness of people on the importance of mangroves, and the various benefits they provide society, among these is the recreational value. Thus, many features and news articles in nationally-circulated newspapers and magazines have dealt with mangroves/ mangrove ecosystems as an eco-tourism site. The mangrove park in Bgy. Old and Bgy. New Buswang, Kalibo, Aklan has been a favourite feature for such popular write-ups, and study site for several studies (Philippine Daily Inquirer, various dates; Walton, et al, 2006). An associated trend in the utilization and conservation of mangroves, therefore, has been the setting up of mangrove parks in various parts of the country, the latest of which is the new mangrove eco-park in Concepcion, Iloilo, which will be established through a 4 million peso – grant from DENR (Abian, April 2008, personal communications).

2.2.2.3. Links with poverty alleviation

Linking cultural ES with poverty alleviation has been scarce in the literature. The study of Walton et al (2006) looks at benefits from tourism income from the mangrove park in Bgy. Buswang in Kalibo Aklan. They found that in 2004, the 75.5-ha park attracted 17,000 visitors which generated US$41/ha for the year. Though not explicitly stated, it can be deduced that the income derived by the local community could have helped the poor households who were involved in the said eco-tourism activities for paying visitors/ tourists. In Palawan, a mangrove park employs people as boatmen and tour guides (Subade, R., personal observation, 2001 and 2004) however due to time constraints it was not verified whether these people came from poor families, which could provide a case of cultural ES generating employment and benefit to the poor (and thus poverty alleviation)

At this stage of the knowledge assessment, it is found that there is a dearth of studies or documented cases of mangroves' cultural ES that directly link with how poverty is alleviated. Recreation, reflection and spiritual enrichment can perhaps make poor people better off, more productive at work, and inspired to strive for economic advancement. Moreover, human well being and poverty is also defined by the extent by which people/ humans can have the opportunity to reflect and get spiritual uplift that they can acquire with their non-extractive interaction with or appreciation of mangroves. This knowledge gap provides an input to the research agenda for the longer (5-year) phase of the ESPA research program.

2.2.2.4. Trade-offs

Just like the subtractability of provisioning ES, C-ES suffer when mangroves are destroyed or converted to other uses. However, there can be some level of C-ES susbstitutionability on other converted use of (former) mangrove areas just like the beach resorts, coastal park, and landscaped coastal subdivisions. This needs further investigation and research, and thus another possible aspect of ESPA that the forthcoming research program has to address.

2.2.3. Supporting ES of Mangroves

Mangrove supporting ecosystem services (S-ES) are necessary in the production of other ecosystem services, such as primary production, production of oxygen, and soil formation (MEA, 2003). Moreover mangrove serves as nursery grounds for fishes, prawns, crabs and shellfishes. They also produce leaf litter and detritus material (about 3.65 tons of litter per hectare per year according to Melana et al, 2000) which provides a valuable source of food for marine animals, wildlife habitat. Furthermore, mangrove areas provide a medium for biodiversity enrichment through time. The S-ES is obviously connected to the P-ES, since the former generate more of the latter, i.e., as more S-ES are generated from mangroves, more fish and other organisms can live in the mangrove areas, thereby generating more provisioning ES

This ecosystem service, therefore, enables mangrove ecosystem to generate more of the provisioning services.

2.2.3.1 Assessment of national information sources

One can easily say that the geographical spread of materials on S-ES of mangrove can be surmised from what is already pointed out above. A closer look on this literature shows a great lack on evidences or documentation of S-ES, i.e., "benefits derived by people from the regulation of ecosystem processes, such as climate regulation, erosion control, water purification, regulation of human diseases, etc."

2.2.3.2. Trend/change dynamics

Logically as mangrove areas decline, the S-ES of mangroves will also decline. Moreover, in the recent years, more literature explicitly discuss the S-ES that can be derived from mangroves, though specific case when a group of people (or particularly poor people) acquire such is almost absent.

2.2.3.3. Links with poverty alleviation

The literature reviewed makes no direct mention of supporting service of mangroves in relation to poverty issues.

2.2.3.4. Trade-offs

The literature reviewed makes no direct mention of trade-offs from supporting services of mangroves.

2.2.4. Regulating ES of Mangroves

2.2.4.1. Assessment of national information sources

Regulating ecosystem services refers to the benefits derived by people from the regulation of ecosystem processes, such as climate regulation, erosion control, water purification, regulation of human diseases, etc. Various articles on Philippine mangroves have mentioned their regulating functions/services like coastal protection, i.e. protection of shore and estuaries from storm waves and erosion (Melana et al, 2000; Walton, et al 2006; Primavera et al, 2005; Jannsen and Padilla, 1996; Gilbert and Janssen, 1997), and their function/service as pollution sink for nearshore waters. However, the link of these functions to human welfare or human well-being is usually general, implied or silent in the literature. Furthermore, the linkage of R-ES to poverty alleviation is absent. It is of interest that the frequently flooded urban areas in CAMANAVA, Metro Manila and coastal/ riverine Iloilo City were formerly mangrove areas. The latter shows the inter-temporal trade-off between regulating service of mangroves and the provisioning (shelter area) ES of now converted formerly mangrove areas. The sad thing is, many people who reside in these vulnerable and hazard-prone (formerly mangrove) areas belong to the urban poor.

Williams, et al (2007) noted that in comparison to their counterparts in Australia, "in the Philippines, fishers in their small boats seek shelter in the nearest mangrove at the sight of a typhoon" (p.366). Moreover mangroves protect the environment by protecting coastal areas and communities from storm surges, waves, tidal currents and typhoons. The crown and stem of mangroves serve as physical barrier. Their specialized roots trap and hold sediments and siltation from the uplands. Further mangroves promote clear water and the growth of corals and sea grasses. (Melana, et al, 2000)

One can easily say that the geographical spread of materials on mangrove can be surmised from what is already pointed out above. However, a closer look on these literatures shows a great lack on evidences or documentation of R-ES, i.e., "benefits derived by people from the regulation of ecosystem processes, such as climate regulation, erosion control, water purification, regulation of human diseases, etc."

2.2.4.2. Trend/change dynamics

Logically as mangrove areas decline, the regulating ES of mangroves will also decline. Moreover, in the recent years, more literature explicitly discusses the regulating ES that can be derived from mangroves, though specific case when a group of people (or particularly poor people) acquire such is almost absent.

2.2.4.4. Trade-offs

Just like the trade-off between two forms of provisioning, the conversion of mangrove areas to fishponds shows an example of tradeoff from one form of ES (provisioning and regulation as provided by the mangrove forest/ mangrove stand) to another (provisionging ES as food provider through former mangrove areas converted to fishponds

2.2.5. State of Knowledge Gaps

The preceding review of literature points out to knowledge gaps that will inform the development of a research strategy to support the maintenance of ecosystem services explicitly for poverty alleviation (PA). In particular the following identified knowledge gaps can serve as inputs to the planned five year ESPA-NERC research program:

1. Though there are quite a number of undertaken studies and projects which deal with mangroves, most of those which in varying degrees, touch on ecosystems services (and hopefully human welfare/poverty alleviation), dealt with the P-ES. However, while P-ES were discussed, explaining or indicating linkage with human welfare was not automatic. Those which discussed P-ES and/ or human welfare implications rarely explained the linkage between the P-ES and PA.

2. There is a dearth of studies on other ecosystem services such as C-ES, R-ES and S-ES and their link with poverty alleviation. Thus we cannot really tell to a great extent how these ES benefit the poor, or how ES addresses PA.

3. While there are several studies on R-ES and S-ES, their link with PA is absent in the literature.

4. No delineated study on mudflats which are overlapping, associated ecosystems. It is believed that they are just included by most of the studies on mangroves as part off mangrove areas

2.3. Seagrass

2.3.1. Provisioning ES of Seagrass

2.3.1.1. Assessment of national information sources

In determining the geographical spread of information sources on the provisioning ES of sea grasses in the Philippines, there is very scant literature which can draw the nationwide confirmation that indeed sea grasses have provided goods and services to people, except for the implied provision of fish products harvested from fishing grounds where sea grass abounds, an example of which is the Bolinao sea grass area (Sotelo-Fuentes, 2007).

2.3.1.2. Trend/change dynamics

Seagrass meadows naturally occur in sheltered, muddy estuaries and coastal areas which are usually adjacent to densely populated areas that serve as centers of transportation, commerce and industry (BFAR-NFRDI-PAWB, 2005). Thus, seagrass communities / meadows suffer from human activities like establishment of human infrastructures, encroaching of human settlements, fishing, boat navigation, gleaning, dredging and establishment of amenities for recreation and tourism (BFAR-NFRDI-PAWB, 2005).

Fortes and Santos (2004) noted that “from surveys in 96 sites, a total of 978 km² of seagrass beds have been identified in the country, mostly in northwestern, western and southern portions, with outlying islands having sizable beds. A significant portion of the coastal habitats is at high risk of being lost in the next decade. About half have either been lost or severely degraded during the past 56 years (Chou 1994; Fortes 1994), and the rate of degradation is increasing.

Among the marine and coastal habitats, sea grass meadows or sea grass communities manifest signs of degradation due to the combined effects of natural calamities [which include climate change effects],

predation, and anthropogenic stress such as aquaculture, deforestation, siltation, and destructive fishing methods (Fortes, 1990, as cited in Barut et al, 1997, and in Subade, 2007).

2.3.1.3. Links with poverty alleviation

Among the various products and traditional uses of sea grasses that people can avail, are: woven baskets, burned for salt and soda, stuffing for mattresses, roof thatch, upholstery and packing material, compost for fertilizer, insulation for sound and temperature, fiber substitute in making nitrocellulose, piles to build dikes, cigars and children's toys. Contemporary uses include, sewage filters, coastal stabilizers, paper manufacture, source of useful chemicals, fertilizer and fodder, food and medicine for humans (Fortes, 1990; cited in Subade 2007). Sotelo-Fuertes (2007) recently reported that in Bolinao, Pangasinan, "sea grass meadows are habitat of rabbit fish, known locally as *padas* when in juvenile stage, and *barangan* in mature stage. Padas is processed into *bagoong* (salted fish), while *barangan* is processed into *danggit* (salted and sun-dried fish). Hundreds of residents are dependent on *padas* and *danggit* which are traditional products of the town. It is believed that several coastal communities, particularly those dependent on fishing must have been dependent in sea grass beds/ meadows for their livelihood or subsistence (Subade 2007).

Gleaning and collection of sea shells and sea cucumbers are also prevalent in seagrass beds such as the reef flats of Bolinao and Anda in northwest Philippines (Mc Manus 1989). Women dominated the gathering of food from accessible areas close to home, handpicking organisms for the day's meals. They gather edible seaweeds, conch shells and bivalves among others.

To date, there are scant studies or written documentation of geographical coincidence of poverty with sea grass ecosystems and ecosystem services. We can just assume that the sea grass ES can have their role in the lives of the poor, wherever or whenever they are adjacent to such poor communities. The scarcity of study on the above therefore constrains us from pinpointing or discussing any issues of access to ES benefits by poor people. However, as a commons, sea grass will obviously be covered by property rights issues and the need to establish such. The community-based or co-managed approach to integrated coastal zone management (ICZM) therefore provides a likely suited intervention option which can address equity, and where needed, greater access by the coastal poor on ES benefits. This state of knowledge and gaps on P-ES of segrasses therefore provides another niche and area for the research agenda of ESPA-NERC in the planned five-year research program.

2.3.1.4 Trade-offs

It is obvious to expect that with the degradation of marine resources and the seagrass habitats therein, reduction of various ES types will follow, though at various temporal and spatial considerations. Subtractability of ES benefits could indeed be seen in the reduction of dugong and marine turtle population. Moreover, the perennial (usually short term) need to meet the increasing demand for shelter and human settlements of burgeoning population has resulted to associated environmental problems such as sewage pollution, habitat destruction, siltation and sedimentation (as cited in Fortes and Santos, 2004) which rendered heavy toll and tradeoffs ---- damaged and decimated sea grass meadows

2.3.2 Cultural Ecosystem Services of Seagrass

2.3.2.1. Assessment of national information sources

Except for cognitive development or educational/research purposes, information and literature on how people particularly the poor avail of this cultural ES is nil. The various studies on the biological aspects of Philippine sea grasses are obvious evidences of derived benefits from them which caters to the cognitive development or educational and research needs.

2.3.2.2. Trend/change dynamics

The literature reviewed makes no direct mention of trend of cultural services of seagrass in the Philippines.

2.3.2.3. Links with poverty alleviation

The literature reviewed makes no direct mention of cultural service of seagrass in relation to poverty issues.

2.3.2.4. Trade-offs

The literature reviewed makes no direct mention of trade-offs from cultural services of seagrass.

2.3.3 Supporting Ecosystem Services of Seagrass

2.3.3.1. Assessment of national information sources

Fortes and Santos (2004) explains that, “seagrass meadows support a rich diversity of species from adjacent systems and provide primary refuge for both economically and ecologically important organisms. Their leaves support epiphytic organisms while marine animals graze on the epiphytes and on the seagrass itself. Seagrasses are sensitive to environmental fluctuations. Species coming from neighboring systems encounter "marginal conditions" and are at the extremes of their tolerance levels to environmental alterations in seagrass habitats. This sensitivity makes seagrasses useful indicators of changes not easily observable in either coral reefs or mangrove forests”

Fortes (in Ong et al 2002) indicated that fish and shrimps are probably the most important components of seagrass beds. The major invertebrates found in the beds are shrimps, sea cucumbers, sea urchins, crabs, scallops, mussels and snails while major vertebrates include fish (e.g., Siganids) sea turtles and sea cows. The sea cow (*Dugung*) maybe the most important and which is considered endangers species since it almost exclusively depend on seagrass for food.

Citing Amesbury and Francis (1988), McKenzie (2007) notes that “tropical seagrass are important in their interactions with mangroves and coral reefs. All these systems exert stabilizing effect on the environment, resulting in important physical and biological support for the communities”

Sea grasses sustain high primary production (Vermaat, et al, 1995; Agawin et al. 1996) and provide habitat for economically important species (Fortes 995) as well as those that are not recognized economically by man but are necessary for the growth and survival of those that are recognized economically. Philippine sea grasses are important food for marine green turtles and dugongs, that is why these marine mammals could be found visiting or maybe inhabiting the shores of Guimaras (Governor F. Nava and Dr. L. Aragones, personal communications, April 2008) the Tubbataha Reefs National Marine Park (personal observations, R.F. Subade, 2004) and the vicinity of Calauit island Palawan, where sea grasses are also found.

On the other hand, seagrass beds stabilize soft bottoms primarily through the dense matted root system. They also trap sediment, thus preventing siltation to the coral reef area.

2.3.2.2. Trend/change dynamics

The literature reviewed makes no direct mention of trend of supporting services of seagrass in the Philippines.

2.3.2.3. Links with poverty alleviation

The literature reviewed makes no direct mention of supporting service of seagrass in relation to poverty issues.

2.3.2.4. Trade-offs

The literature reviewed makes no direct mention of trade-offs from supporting services of seagrass.

2.3.4. Regulating Ecosystem Services of Seagrass

2.3.4.1 Assessment of national information sources

Regulating ecosystem services refers to the benefits derived by people from the regulation of ecosystem processes, such as climate regulation, erosion control, water purification and regulation of human diseases.

This literature review was not able to uncover sources that cited the regulating ecosystem services which sea grass has provided to the inhabitants of the Philippines. However, several articles/ sources which did not deal with Philippine sea grasses, cited the regulating ES of sea grasses (in general, regardless of country or geographical area), such as help in the reduction of wave and current energy; help in the filtration of suspended sediments and stabilization of bottom sediments (Fonseca and Cahalan, 1992 as cited in English et al., 1994). Sea grass on coral reefs, particularly the reef flats adjacent to estuarine areas serve as nutrient sinks, by buffering and filtering nutrient and chemical inputs to the marine environment (Short and Short, 1984, as cited in English et al, 1994). It is unfortunate that the articles covered did not cite this ES of sea grasses. Morevoer, while various biological studies have been undertaken on Philippine sea grasses, these have examined morphological and other biological variables like lead density, leaf production, leaf turnover, effect of sediments on sea grasses, etc. The great lack of studies looking at the R-ES of sea grass points to the knowledge gap that needs to be addressed by future research agenda and undertakings, which includes the ESPA-NERC program.

2.3.4.2 Trend/change dynamics

Yap (2000) notes that “Seagrass beds, since they frequently occur up to the intertidal areas, are vulnerable to the impacts of almost any coastal activity. They have been dredged in order to clear waterways for navigation. They are impacted by sediments washing in from the land that either bury the organisms, or decrease light penetration into the water column which is crucial for photosynthesis. Seagrasses are also subject to various forms of pollution which enter coastal waters from mostly land-based activities.”

2.3.4.3 Links with poverty alleviation

Sea grasses abound in several areas of the country from Bolinao Pangasinan in the North to areas in Tawi Tawi and the Turtle Islands which are split among the Philippines and Malaysia. There is a lack of documentation and written reports on poor communities or people’s settlements which rely on the nearby sea grasses, except for the one on Bolinao by Sotelo_Fuertes (2007). One can just speculate that the regulating ES of sea grass will somehow benefit the coastal poor. A personal observation and thought could tell us that sea grasses somehow slowed down the inflow of spilled bunker oil onwards the coast of Cubelo Cove, Semirara Island, Antique, during the December 18, 2005 oil spill which was the second biggest in the country’s history (R.F. Subade, personal observation and notes, March 2006). In one coastal barangay in Guimaras, Philippines, the 20-hectare sea grass area somehow provide sea bottom stability and food to the resident and visiting marine organisms (R.F, Subade, personal observation, May 9, 2008; interview with a barangay official). It can be argued and be likely verified by research that sea grass regulating ES benefit poor coastal communities in the country. This will need further investigation and research in the five year NERC-ESPA program.

Any marine conservation should therefore include the protection and sustainability of sea grasses and the assurance that the coastal communities, particularly the coastal poor will access and derive benefit due to such sustaining of regulating ES and other ES of sea grasses

2.3.4.4 Trade-offs

Just like the predicament of other ecosystems and ES, the trade-off between economic growth and long term sustainability or sustainable development can be seen on the state of the country's seagrasses. The decimation and damage to such valuable ecosystems have been due to coastal development and coastal urbanization that resulted to habitat alteration and loss. It is therefore imperative that development plans consider the immediate restoration and protection of segrasses so that the future generations, particularly those who have less in life, can still enjoy the benefits from such.

In the intra-generation scene, poor coastal dwellers and small fishers suffer the brunt and the reduced catch consequences due to the marine/coastal pollution that comes from increased agricultural production and urbanization.

2.4. Assessment of Ecosystem Services of Fisheries

2.4.1. ES of Fisheries

2.4.1.1. Assessment of national information sources

There has been a preponderance of published reports on projects undertaken under the cover of coastal resources management in the Philippines, which has provided a substantial amount of information on the conditions of fisheries in the Philippines. The major projects are the Fisheries Sector Program undertaken by ADB-BFAR (1992-1997), Coastal Resource Management Project (CRMP) of USAID-DENR (1996-2004), and the Fisheries Resource Management Project (FRMP) by ADB-BFAR (1999-2005). A National Stock Assessment Program (NSAP) has also been initiated by BFAR since 1998.

2.4.1.2. Trend/change dynamics

Figure 5 illustrates the trend of decline in demersal species abundance in Philippine shelf waters during 1947 to 1995. The index of demersal abundance (stock density in $t \cdot km^{-2}$) was computed using the swept area method from various trawl surveys conducted in the Philippines. Data for 1947 to 1980 are from Silvestre et al. (1986), while data for 1981 to 1995 are consolidated from surveys in selected fishing grounds, i.e. Lingayen Gulf (Silvestre et al. 1991), Ragay Gulf and Burias Pass (Federizon 1993), Manila Bay (Armada 1994), San Miguel Bay (Cinco et al. 1995), San Pedro Bay (Armada 1994), and Tayabas Bay (Resource Combines 1997). The data are based on arithmetic means as much of the original data are available for log-transformation and recomputation of geometric means. The stock density estimates also incorporate "learning effects" as given by Silvestre et al. (1986). Despite the paucity of surveys, Figure 5 clearly illustrates the substantial depletion in demersal abundance in the country's trawlable areas.

Consequent to the biomass decline, species composition changes are also observed. Silvestre (1990) suggested that trends in the species composition changes from trawl surveys are reflective of growth, recruitment and ecosystem over-fishing: (1) disappearance or greatly reduced numbers of sharks and rays (together with other large, long-lived species); (2) increased squid (Loliginidae) abundance; (3) increased abundance of shrimps in relation to fish biomass; and (4) increased abundance of cardinal fishes (Apogonidae) and puffer fishes (Tetraodontidae).

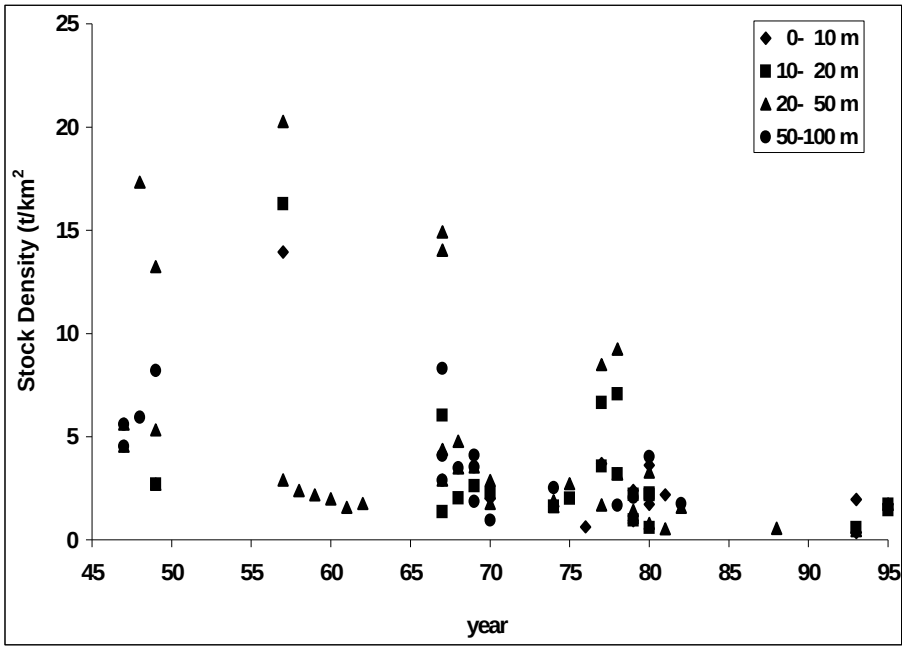


Figure 5: Scatter diagram of demersal stock density ($t \cdot km^{-2}$) estimated from different trawl surveys conducted in the Philippines from 1947 to 1995. Data for 1947-1980 are from Silvestre et al. 1986 and data for 1981-1995 are consolidated from recent trawl surveys). Source: Barut et al 2004.

The comparative profile of nine bays by the FRMP Project (SuPFA 2006) reveal several trends that may as well be representative of conditions in the marine fisheries resources in the country. Foremost is the observed biological and ecosystem overfishing in all bays with only two showing possibilities of not exceeding its fishing capacity. For example, the projected losses due to harvest of young pre-mature fish range from 10%-30% of total fish production. Annual losses are estimated to be from PhP30 million in a moderately overfished small bay to over PhP300 million in a highly overfished Gulf. The two bays still considered to be within fishing capacity level also show fish food deficits due to low annual catch rates.

The FRMP resource and socio economic assessment lead to the conclusion that there are twice as many municipal fishers as can sustainably be supported by the country's coastal waters (SuPFA, 2006). The same source produced projections, using variable composition FISH-BE models, that point to needed large reductions in number of municipal fishers, ranging from 31% (in Davao Gulf) to 84% (in Lingayen Gulf) if fish catches are to be made sustainable over the long term (10-20 years). Given the aforementioned state of the fisheries, strategies that aim to increase fishing catch will only lead to more poverty.

SuPFA's analysis of FRMP data showed that high revenue per fisher is related directly to high municipal catch rates (kg/fisher/trip). In turn, catch rates are relatively high in fishing grounds where the contributions of stationary gear (fish corrals, barrier nets, etc.) and trawls are also high. On the other hand wide-mouth fishing grounds exhibit low fisher density and were not as productive as embayments. Low revenue and low catch diversity is associated with use of bagnets in bays. Reef associated resources comprise a higher proportion of total landings in bays where spearfishing (with and without compressors and lights) contributes significantly to total catch. Soft bottom demersal catches are high in bays where gillnet and trawl contributions are high.

BAS statistics showed that the projected declining trend in municipal fisheries production at project appraisal was reversed to a positive trend during and after the project implementation period. The municipal marine production increased by 6.8% annually during the implementation period and further to 8.7% one year after project implementation. Fish production without the project was projected to be 111,466T while actual fish production upon project implementation was recorded at 131,741T.(p. 83 ADB report)

Through the demonstration effect of early projects like the CRMP and FSP, the shift in sector focus moved away from increasing fish production to a sustainability approach represented by coastal resource management (CRM).

2.4.1.3. Links with poverty alleviation

Geographical coincidence with poverty

The FRMP focused on municipal fishers and covered 100 municipalities in 18 bays and gulfs, among 26 priority bays in the Philippines. It categorically stated as among its main goals the alleviation of the extensive poverty of coastal fishing communities by promoting income diversification, reducing reliance on fishing, and increasing incomes and living standards (ADB Project Completion Report, 2007).

Contribution to well being

Filipinos obtain 22% of their total protein requirements from fish, which is actually 56% of their animal protein intake (Espejo-Hermes, 2004). A paper written on fish demand by Garcia et al, 2004 stated that:

"*The pattern of fish consumption, both in terms of quantity and quality of fish consumed, varies widely among Filipino consumers according to income strata. In 2000, the average value of per capita consumption of fish in the richest quintile is 3.4 times that consumed in the poorest quintile (Table 4). Often, consumers in the lowest income sector purchase*

cheaper fish types (including processed fish), while the more affluent consumers purchase the bigger and more expensive fresh fish."

Table 4: Average consumption of various food commodities in pesos, Philippines, 2000

	Quintile1	Quintile2	Quintile3	Quintile4	Quintile5	TOTAL
Cereals	2155	2678	2972	3283	3981	3013
Fish	745	113	1400	1728	2535	1504
Meat	315	751	1377	2329	4286	1811
Fruits/veg	472	734	1008	1360	2357	1186
Beverages	145	296	458	678	1223	560
Others	887	1556	2427	3675	7093	3128
Total	4720	7128	9642	13 052	21 475	11 204

Source: Family Income and Expenditure Survey, 2000 as cited in Garcia et al., 2004

Assuming that the municipal fishers belong to the lower quintile consumers who are mostly rural, it is noteworthy that the fishers who catch high and low value fresh fish are the ones consuming less of it. As presented in Table 5, urban (81%) percentage expenditure on fresh fish is higher than that of rural (74%) while the reverse is true for the percentage expenditure on processed fish. For instance, rural consumers prefer to purchase more of the lower value processed fish like salted fish (4%) rather than high value fresh squid or shrimp (both 2 %). It can be that these consumers (municipal fishers) cannot afford to buy the higher value fish or it can also be that they would opt to sell their high value fresh fish catch for some amount and purchase lower priced fish so that they can have spare money to buy other necessities. On the other hand, urban consumers who are assumed to belong on the higher quintile prefer high value fresh fish species like milkfish (19%) more than that of the lower value processed fish like canned fish (7%).

Table 5: Shares in expenditure and prices of various fish categories, Philippines, 2000

Fish Categories	Expenditure share (%)			Price per kg (pesos)		
	Total	Rural	Urban	Total	Rural	Urban
A. Fresh fish	**78**	**74**	**81**	**-**	**-**	**-**
Aquaculture species						
Milkfish	15	10	19	82	81	82
Tilapia	13	11	14	60	60	60
Shrimp	4	2	4	189	172	201
Shells/crabs	2	2	2	95	92	97
Marine species						
Roundscad	15	14	16	56	53	58
Anchovies	3	4	3	50	49	51
Squid	3	2	3	88	84	91
Other fresh fish	23	28	20	72	65	76
B. Processed fish	**22**	**26**	**19**	**-**	**-**	**-**
Dried/smoked fish	11	14	10	90	83	95
Canned fish	8	8	7	60	60	60
Salted fish	3	4	2	36	35	36
Total	**100**	**100**	**100**	**-**	**-**	**-**

Source: Family and Income Expenditure Survey, 2000 as cited in Garcia et al, 2004

In as much as most of the bays are overfished, this means that too many fishers are catching too few fish, which in turn may explain why most fishers live below the poverty line. As already mentioned, the number of municipal fishers has to be reduced to 31%-84% of current levels for fishers to obtain a decent livelihood from fishing (BFAR-FRMP SuPFA, 2006).

An evaluation of FRMP (ADB) claims positive economic impact on fishing communities covered by the project. These include increase in fishing incomes brought on by both bigger fish catches and fish size; the reappearance of high value fish species due to improved law enforcement and spillover effects of resource enhancement projects; more diverse income sources, employment, alternative livelihoods for fishers, women and the fishers associations which were instituted through this project. Improved incomes meant beneficiaries increased spending on fishing and household assets, education of their children and home improvements. Benefit distribution analysis showed a poverty impact ratio of 0.67, indicating that the poor in all subsectors of the economy have realized a greater share (67%) of the total net benefit generated by the Project (p. 69). However the extent of reduction in poverty incidence can only be ascertained three years after project completion.

The evaluation report of the Fisheries Sector Program which preceded the FRMP claims poverty level in the Program area was reduced from 80% at preproject level to 65% at project end. In two case study bays, annual household income of marginal fisherfolk almost doubled from P22,150/year in 1992 to P43,244/year in 1995 and the incidence of poverty was reduced from 80 to 59 percent in Panguil Bay. These improvements were limited to areas with at least 4-5 years of effective program implementation.

Role of the ES in the lives of the poor

In a study conducted by Padilla et al, 1994, where a total of 226 fisher respondents from San Miguel Bay were surveyed and monitored, majority of them (74%) were full time fishers and only a few (26%) were part-time fishers. The computed average monthly income of these fishers or crew were found to have a huge differences, ranging from P632 to P4,300. From the sample of respondents, it was found that only one of them lives above the poverty line. This situation is not only in San Miguel Bay but in other areas as well. As shown in Table 6, the estimated annual incomes of municipal fishers were relatively low across regions.

Table 6: Income estimates of municipal fishers from various case studies.

Study site	Estimated income	Source
Misamis Oriental	$750 for owners of motorized vessels; $625 for owners of non-motorized vessels	Herrin et al. (1978)
Nationwide	$675 of fishing households but including non-fishing activities	Librero et al. (1985)
Lingayen gulf	$206 per year	Añonuevo (1989)
Fisheries Sector Project selected areas	$1 059 weighted average for owners of motorized (27%) and non-motorized (63%)	PRIMEX (1996)

Source: Cruz-Trinidad, A., 2003

Issues of access to ES benefits by poor people

Through its income diversification component, FRMP decreased pressure on fishing resources while at the same time providing income sources for the displaced fishers. The goal was to encourage the gradual exit of marginal fishers from capture fisheries. By the end of the project, it reported 537 microenterprises benefiting 13,104 fisherfolk, although only 106 of these had positive income accrued during implementation (ADB completion report 2007). These microenterprises involved local government investments in organizing and strengthening community groups and loans extended by NGO's.

Half of their targets for transferring mariculture projects to fishers organizations were only partially met because there were not enough sites suitable for mariculture parks. However the establishment and expansion of seaweed production were more successful.

Interventions options to improve ES access

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2.4.2 State of knowledge and gaps

The sustainability of project interventions after the project end, such as microenterprises, improved enforcement, fishers organizations, protected areas, will still have to be evaluated. CRM proponents have acknowledged the importance of the following inputs critical to project sustainability: monitoring of interventions by LGU, strengthening of links to credit and financing institutions, fostering and strengthening links between microenterprises and markets, continuing campaign for awareness, advocacy and capacity building on CRM for LGU's, fisherfolk, women's groups and other stakeholders in the coastal communities.

There is a need to develop and try out community and LGU-based monitoring schemes so that the primary stakeholders themselves are self-sufficient (not relying on availability of expensive externally generated surveys) and can generate timely information to guide policy and decision-making regarding resource productivity. Action research should accompany this initiative to test its doability and effectivity in generating useful monitoring information and participation from stakeholders.

2.4.3 Trade-offs

User conflicts
The introduction of mariculture among the FRMP microenterprises may create nearshore pollution.

The earlier mentioned conflict between municipal fishers and commercial fishers, reflect a trade-off wherein the latter lose their illegal access to municipal waters due to better enforcement of fisheries laws and policies while the municipal fishers now have exclusive fishing rights to the municipal waters. This is expected to decrease the pressure on this zone although this is offset by new entrants into subsistence fishing, driven by population growth and lack of alternative employment.

When we link data on improved catch despite the establishment of no-take zones or marine protected areas, it appears like marine sanctuaries can only benefit the fishers. However the data reported as BAS statistics may not coincide with the actual experience of fishers who are affected by protected areas. Eder (2005) caution that stakeholder should ask question like 'which particular fishers are catching or are likely to catch fewer fish or now will have to work longer or harder to catch the same amount of fish as a result of CRMP initiatives.'

Gender concerns: FRMP planning did not give attention to women's involvement in community organizing and project targeting; neither were they reflected in the monitoring and evaluation tool designed by the Project. However the end-of-project reports observed women's participation to be significant despite the project's initial oversight. Women's roles were noted in resource management activities, in membership and leadership even in male-dominated people's organization.

Societal conflicts
The trade-offs between resource conserving measures and individual good are premised on the belief that societal goals are on the same side of conservation. However Eder (2005) raises the point that perhaps the notion of societal good lies between the polar notions of individual good and common good. Moreover how is common good determined in coastal resource management? Is there really a bottoms-up or real participatory decision-making or do political alignments and processes favour certain groups? Is there equal sharing of the burden of coastal resource conservation across class, ethnic and gender lines

3. SUMMARY

3.1 Key Knowledge Gaps

The preceding review of selected available literature on the Philippines points out to knowledge gaps that will inform the development of a research strategy to support the maintenance of ecosystem services explicitly for poverty alleviation (PA). In particular the following identified knowledge gaps can serve as inputs to the planned five year ESPA-NERC research program:

1. Though there are quite a number of undertaken studies and projects which deal with marine and coastal ecosystems, most of which in varying degrees touch on ecosystems services, dealt mainly with the provisioning ES. However, while provisioning ES were discussed, explaining or indicating linkage with human welfare was very rarely mentioned/ analyzed. Those which discussed provisioning ES and/or human welfare implications rarely explained nor analyzed the linkage between the provisioning ES and poverty alleviation. This missing aspect could have indicated whether the coastal poor have been alleviated (or not) of their conditions by the ES they availed. The deliberate and explicit indication, study and analysis of such ESPA linkage will hopefully increase the probability of truly improving the conditions of the coastal poor, while coastal/marine ecosystems are protected and conserved.

2. Studies on the cultural, spiritual and ceremonial significance of the seas and coastal ecosystems, as well as their psychological and aesthetic contributions to Filipinos have not found its way into the literature in the past couple of decades. The cultural value for those who live in proximity (particularly the poor) has not been given much attention. This should especially be so for the poor coastal dwellers, who have little resources to visit appropriate places for recreation and spiritual rejuvenation. Coastal folks who live in the vicinity of the coastal ecosystems (be it mangroves, coral reefs, sea grass, tidal flat or otherwise) have a more intimate knowledge of this environment and provide a resource to society with their indigenous knowledge. If society recognizes this contribution, the poor who possess this knowledge have gained human and social capital, which is a form of poverty alleviation. While no study seems to have addressed it, this kind of framework may be investigated in future work.

3. While various studies have shown the vulnerability of marine species and ecosystem to overexploitation, how people (particularly the poor) value these species and associated habitats and ES needs be researched and understood. This knowledge can guide and inform future research strategy and policy

4. Studies that experiment on livelihoods that capitalize on and support the supporting and regulating services of ecosystems, other than its provisioning functions. This current literature review has highlighted the paucity of studies on these services. The direction of recommendations for alternative livelihoods for fishers is for them to seek these in non-aquatic or land-based enterprises. However the suggestion to experiment on making conservation pay for itself (White et al. 2002) has value and may be more acceptable to the fisher who prefers to remain with the sea as his/her source of livelihood.

5. There is lack of recognition of the non-material indicators of poverty/well-being within the literature on ecosystem services. The cited links to poverty are chiefly monetary income from increased catch and tourism services. However there is scant discussion of the impact of interventions on health, nutrition, education, social networks and relationships. This absence reflects the narrow view that poverty alleviation can be handled simply by increasing incomes and material well being.

6. For coral reefs (and even the other coastal ecosystems), although they are exceptional reservoirs of natural bioactive products, we have not encountered studies on this in the Philippines. It is likely that such studies form part of R&D of wealthy pharmaceutical companies. But these knowledge are confidential in nature (not open to public scrutiny). Recently a newspaper account announced a new research program (Pharmaseas) being undertaken by a university research institute which explores this area. The contribution of this facet to poverty alleviation (or exacerbation) is unknown. Future studies need to include how local communities particularly the coastal poor are (or will be able) to

share from the benefits of marine-based medicines/pharmaceuticals and other products developed by big corporations, that are mostly foreign.

7. The most appropriate context and role of ESPA in the larger framework of integrated coastal management (ICM) or integrated coastal zone management (ICZM) need to be located. There is a need to uncover how an ecosystem services based framework can contribute to the existing frameworks which emphasize coastal resource management and community empowerment. This is indeed a vital input in the development and implementation of the incoming ESPA-NERC research program.

8. Critical factors for effective enforcement of MPA/s which will capture the involvement of fisherfolks and increase the benefits to poor fishers have to be identified. This will need experimentation on strategies to increase the current small range of economic incentive packages to complement good coastal mgmt. The schemes that have been tried don't often employ people to the extent required to wean them away from dependence on depleting coastal resources.

9. Demographic research on coastal communities is needed to capture the dynamics connecting population growth and depletion/sustainability of coastal resources.

10. How to optimally undertake fruitful inter-disciplinarily in ecological systems cum poverty research, avoiding the trend in the past where natural scientists focus only on the biophysical to the exclusion of the social science aspects and vice versa. Similarly some CRM studies look only at governance issues and ignore the biophysical indicators, when both need to be interrelated to optimize learning and sharpen analysis.

11. There is an absence of delineated study on mudflats which are overlapping, associated ecosystems. It appears that they are included by most of the studies on mangroves as part of mangrove areas.

3.2 Matrix of Ecosystem Services and Poverty Link, Trends/Drivers, Trade-offs, and Status of Knowledge and Knowledge Gaps

Ecosystem Service Type	**Ecosystem Services (specific)**	**Ecosystems involved**	**Poverty Link**	**Trends & drivers**	**Trade-offs**	**State of knowledge &**	**Knowledge gaps**
Provisioning	Provides food, fuel, fiber, fresh water and incomes for coastal people and the society at large Reef fisheries contribute 15-30% of municipal fisheries production or 10% of total fish production in the Philippines.	MANGROVES, CORAL REEFS, SEAGRASSES DEEP OCEAN, FISHERIES SYSTEMS	Small scale fishers less able to cope with declines in restriction to fishing effort Women and children most affected by MPA's and when oil spills damage habitats Enforcing decreased fishing effort will require providing viable alternatives for displaced people. In recent years, marine conservation projects in most cases involve alternative livelihood components, which can address low income and alleviate poverty	Decreasing fish catch, shifts in species composition, possible localized extinction brought about by over fishing further driven by policies of incentives, subsidies, tax exemptions, lower tariff rates and growing lucrative export market. Increase in population especially through in-migration to coastal areas. Degradation of reef cover, low fish bio mass. Continued use of destructive fishing methods like blast fishing, and cyanide fishing Industrialization has increased marine pollution from effluents of industries and household, but research on this was not accessed. Advocacy and increased acceptance for coastal resource management is noted. Establishment of MPA's which increase coral cover and fish abundance, with spill-over effects, but in very limited areas with good enforcement and within CRM framework.	Trade-offs between short-term yields and long-term sustainability. Between goals of fishers to improve environ so their catch improves VS pure conservationist Fisheries rehabilitation will need a reduction in number of fishers to 31-84% of current levels. Closure of fisheries in most bays is a more severe approach. Trade offs between conservation for future generations and current need requiring more natural resource extraction. Seagrass and CR can be restored by drastically reducing fishing effort and negative impacts of terrestrial based threats. Will require network or clusters of MPA's for effectivity. Thus more areas need to be set aside and enforced. This is however also costly to protect as no take areas. Women most	Habitat degradation is concomitant with human resource use. CRM and MPA are associated with higher levels of fisheries knowledge, better information exchange, satisfaction with fishery arrangements, benefits from marine reserve, quickness of resolving community conflicts.	Lack of knowledge of the sustainable yield of local stocks Lack of detailed info to classify and provide exact estimate of entire status of coral health in Phil. In mangroves, no comprehensive nationwide study on mangroves link with poverty alleviation except those estimating national hectarage. Few, if any, are the studies quantifying and describing loss and consequent benefits to human population and the economy in the Philippines of CRM, mangrove reforestation, and MPA's, extent these benefit the poor or enable them to breach poverty threshold. No studies on how coastal folks cope with declines in reefs productivity, e.g. migration patterns of family members, fertility , population growth. A lot is still unknown on how to generate more effective participation in general community affairs and in fisheries management.

Ecosystem Service Type	**Ecosystem Services (specific)**	**Ecosystems involved**	**Poverty Link**	**Trends & drivers**	**Trade-offs**	**State of knowledge &**	**Knowledge gaps**
			if properly undertaken Filipinos obtain 22% of their total protein requirements from fish, which is actually 56% of their animal protein intake Since fish are cheaper than meat, the poor depend more on fish as protein source However, the poor generally eat less fish compared to the rich	Establishment of FARMC's is mandate and has potential for better enforcement capability if implemented and truly community based. Increased tourism built around coral reefs provide alternative and better incomes, and lessen pressure on fish resource	disadvantaged as affects gleaning. Unregulated tourism leads to water pollution, destruction thru boat anchors, careless divers. Fishers still fish, not content with income from tourism, so pressure still there. -Conflicts between competing users.		
	Mangroves provides food and income, incl crustaceans and bivalve mollusks. Mangroves provide traditional medicines. Mangroves provides fodder for livestock. Tannins are used for manufacture of textiles. Nipa shingles, wood, leaves, are used for house construction; poles for fish traps. Mangroves provide wood for domestic fuel, through charcoal and firewood.		Wide range of goods and services provided by mangroves benefit rural coastal poor, e.g. fry gatherers, aquaculture-dependent coastal HH. What is gathered is for subsistence of HH. Medicine extracted from mangrove	In the past, mangrove habitat loss was driven by misplaced policy of subsidies, incentives, tax exemptions favoring land use conversion for commercial /residential use, export for tan barking, rayon to Japan, and aquaculture of shrimps and milkfish. Towards the end of '70s, trend shifted to conservation and sustainable management of remaining mangrove forests, generation of technology for rehabilitation, production and sustainable management of mangroves.	Human activities like domestic use of mangrove products, industrial development will be at the expense of mangroves. Tradeoff between aquaculture products vs mangrove products: if efficiency is the goal, semi-intensive aquaculture is preferred; if equity and environment, then commercial forestry is best alternative. Trade-off between rich and poor, as fishpond leases go to the rich and middle class due to their influence and capital while the poor are deprived of fish products affected by loss of mangroves. Mangrove forest		Success of mangrove rehab initiatives are patchy.

Ecosystem Service Type	**Ecosystem Services (specific)**	**Ecosystems involved**	**Poverty Link**	**Trends & drivers**	**Trade-offs**	**State of knowledge &**	**Knowledge gaps**
	From plantation of nipa fruticans come alcohol for biochemical industries. Propagules are collected for nurseries for transplantation.(M) Flowers and feathers for ornamental use. (M)		provide cheaper alternatives to commercial meds. In few documented studies, sea grass provide coastal people various goods such as woven baskets, upholstery, fiber substitute in making nitrocellulose, paper manufacture, source of useful chemicals, fertilizer, fodder	Seagrass meadows suffer from human activities like human infrastructures, human settlements, fishing, boat navigation, gleaning, dredging, construction activities.	regeneration at the expense of aquaculture production. Tradeoff between mangrove fisheries and aquaculture	Sea grasses are associated with sea turtles and dugongs (sea cows), which are endangered species.	There are very few studies which document goods and services provided by seagrass

Ecosystem Service Type	**Ecosystem Services (specific)**	**Ecosystems involved**	**Poverty Link**	**Trends & drivers**	**Trade-offs**	**State of knowledge &**	**Knowledge gaps**
	Provides building material such as timber and pulp/chipwood from commercial forestry Provides curios & ornamentals for aquarium trade Provides construction materials Pharmaceutical compounds	MANGROVES COASTAL FOREST, SEA GRASS, CORALS	chemicals, fertilizer, fodder,	1950's: govt contract for mangrove logging, exported to Japan to meet growing demand of rayon market. Harvesting is increasing/decreasing in response to demand and supply.	Provision of this service negatively affects: wildlife habitat coastal protection etc	Only general knowledge that mangrove timber is used for construction, fuel, decorative purposes. Same with corals used as ornaments/ curios, construction (in the past), pharmaceuticals. New research program underway to uncover microorganisms in coral beds which may eventually yield anti-pain and anti-infective compounds to treat diseases becoming resistant to current medicines.	Need studies examining valuation, economic and social impact of utilizing corals, mangroves, for construction, crafts, and medicinal purposes.
Cultural	Coastal tourism	CORAL REEFS BEACHES FOREST DEEP OCEAN ENTIRE SEASCAPE, SEA GRASS, FISHERIES SYSTEMS	Coastal Recreation can provide added welfare (through time to rest and reflect) and income earned from firms involved with the coastal recreation (CR, M, SG)	Growing number of thriving tourism related enterprises that are located in reef-based areas which enables tourists to enjoy activities such as diving, snorkeling, dolphin/whale watching, bird-watching & serve as scenic picnic grounds The preservation and rehabilitation of coral reefs continue to generate national and intern'l interest and cooperation, driven by increased global environmental awareness of degradation of marine and coastal ES. Increased environmental	Opening coastal and marine zones to economically- driven tourism creates conflicting use with traditional users, but can be made profitable for the latter, if tourism is planned well and considers needs of displaced groups. Environmental impacts of tourism are often not clearly visible until their cumulative effects have irreversibly destroyed or severly degrades the resources.		-What is the cultural, psychological and aesthetic contribution to human well-being these ecosystems. What is the cultural value of reefs, mangroves, etc for those who live near them? Is it same as value of same to tourists? Do they derive the same cultural benefits as tourists? -How does valuing of indigenous knowledge increase human and social capital, esp for poor coastal dwellers. -Do cultural services of ecosystems make poor people more productive at work, inspired to strive for advancement?

Ecosystem Service Type	**Ecosystem Services (specific)**	**Ecosystems involved**	**Poverty Link**	**Trends & drivers**	**Trade-offs**	**State of knowledge &**	**Knowledge gaps**
				awareness of ES has provided training opportunities to communities which in the process empower them and in trun positively influence enforcement. Tourism tends to be poorly regulated and easily result to ecological harm: poor water quality, inadequate sewage, overabstraction of water, illegal land use in many cases Increasing awareness on recreational value of mangroves e.g. developmt of mangrove parks as alternative conservation strategy (recent trend)			While tourism potential of coral reefs has made them valuable, their cultural value for those who live in proximity has not been given much attention LACK OF STUDIES ON ACTUAL AND POTENTIAL RECREATIONAL OPPORTUNITIES AND BENEFITS FROM SEA GRASS MEADOWS (EX. TURTLE AND DUGONG WATCHING, ETC) Educational need to develop USEFUL methods of biophysical measures for establishing baseline, monitoring and managing of reef habitats. Studies needed on substitutability of converted use of mangrove areas, e.g beach resorts, parks, seascape residential areas. Lack of studies on actual and potential recreational benefits from fishing/ recreational fishing
Supporting	Seagrass meadows support rich diversity of species from adjacent systems and provide primary refuge for both economically and ecologically impt. organisms. Sensitive	MANGROVES, CORAL REEFS, SEAGRASSES SOFT BOTTOM HABITATS' DEEP OCEAN, FISHERIES SYSTEMS		Seagrass communities show signs of degradation due to combined effects of natural calamities, predation, aquaculture, deforestation, siltation, destructive fishing methods.			Lack/absence of studies on link between human welfare and supporting services of these ecosystems. Estimates on total area of seagrass habitat in country is lacking due to technical

Ecosystem Service Type	**Ecosystem Services (specific)**	**Ecosystems involved**	**Poverty Link**	**Trends & drivers**	**Trade-offs**	**State of knowledge &**	**Knowledge gaps**
	to environmental fluctuations not easily observable in either Coral Reef or Mangroves. Coral reefs provide habitat for spawning and rearing of various species. Corals support biodiversity, larval dispersal, and support ecological processes. Mangroves serve as nursery for fishes, prawns, crabs, shellfish. Produce leaf litter and detritus material which provide food for marine animals, wildlife habitat. Also provides medium for biodiversity enrichment. Mangroves support primary production, production of oxygen, soil formation. feeding ground for dugong, green turtles and migratory birds -Fish stocks of various size or species provide prey food for the predator, higher food-chain level species			Anthropogenic impacts affect corals' supporting capability for breeding and spawning of many fish species, and havens for juveniles. Degradation of habitat and bays due to mariculture enterprises, e.g. overcrowding of cages in shallow areas. As mangrove areas decline, the supporting functions will also decline.	Mariculture provides alternative livelihoods and businesses due to improved culture techniques. However if unregulated leads to pollution that affect coral reefs and related ecosystems.		complexity of task. No delineated study on mudflats which are overlapping, associated ecosystems. It is believed that they are just included by most of the studies on mangroves as part of mangrove areas. Studies that experiment on livelihoods that capitalize on and support the supporting and regulating services of ecosystems, other than its provisioning functions.

Ecosystem Service Type	**Ecosystem Services (specific)**	**Ecosystems involved**	**Poverty Link**	**Trends & drivers**	**Trade-offs**	**State of knowledge &**	**Knowledge gaps**
Regulating	Reefs buffer land from waves, currents and storms and prevent beach erosion. Reefs provides atmospheric and climate regulation. Reefs play vital role on nutrient fertility and cycling. Mangroves provide coastal protection from storm waves, typhoons and erosion; pollution sink for nearshore waters. Their specialized roots trap and hold sediments and siltation from the upland. Mangroves promote clear water and growth of corals and seagrasses. Reduce sediments. Seagrass reduce the surge energy from waves	MANGROVES, CORAL REEFS, SEAGRASSES SOFT BOTTOM HABITATS' DEEP OCEAN, FISHERIES SYSTEMS	The link to human welfare and poverty is only implied or silent in literature. Flooding in urban areas are attributed to the land use conversion of mangroves. Urban poor live in former mangrove areas converted to human settlements. In rural coastal areas, mangroves provide buffer or coastal protection for poor households from strong sea current and waves.	Decline in live coral cover, mangroves and sea grass affects regulation service they provide.	Trade-off between regulating service of mangroves and provisioning of human shelter. Coastal development for human settlements and industries can result to damaged sea grasses Increased coastal human settlements imply increased users of coastal and marine resources, resulting to more or over exploitation, which appear unsustainable.		No studies on awareness of values or benefits derived by people from the regulation of ecosystem processes, such as climate regulation, erosion control, water purification, regulation of human diseases.

ANNEX 3 – VIETNAM COUNTRY ASSESSMENT REPORT

Vietnam Country Assessment Report

June 2008

Submitted by:
Centre for Marinelife Conservation and Community Development (MCD)

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I. INTRODUCTION

This national analysis for Vietnam aims to assess the state and trends in ecosystem services associated with marine and coastal systems; driven factors; how they support the livelihoods and well-being of human societies and particularly poor communities in Vietnam; and the threats, opportunities and constraints to these. It will also identify the key challenges for research, as well as current gaps in knowledge and capacity in order to inform the development of a research strategy to support the maintenance of ecosystem services explicitly for poverty alleviation (ODG, 2007). The research was carried out by the Centre for Marinelife Conservation and Community Development (MCD) in collaboration with external research agencies in Vietnam. The research team consists of multidisciplinary experts including marine biologist, human ecologists, coastal resources managers and climate change professionals.

1.1 Coastal and marine ecosystems of Vietnam

Vietnam and the sea

Vietnam is a coastal nation. It is situated in the East of the Indochina peninsula, with an inland area of about 331,212km^2 (General Statistics Office, 2006) and a long coastline of more than 3620km (excluding the coastlines of islands) extending through more than 15 degrees of latitude from 8º30' N to 23º N. It has a marine exclusive economic zone (EEZ) of approximately 1,000,000 km^2 that hosts more than 3,000 small and large islands including the Paracel and Spratlyislands (VACNE, 2004). The fact that each kilometer of coastline is proportioned to about 100km^2 of land area (whereas the world's average ratio for that is 1 km to 600 km^2) and every 1 km^2 of mainland corresponds with about 3 km^2 of sea territory and EEZ (around 1.6 times higher than the world's average) indicates the crucial role of the coastal and marine areas to Vietnam.

Coastal zone delineation

In Vietnam, the inland extent of the coastal zone includes the administrative districts that have coastline, and the seaward boundary extents up to 6 miles from the coastline. Such delineation of the coastal zone is therefore applied for the purpose of this assessment, where both coastal and marine ecosystems are described and analyses are made.

Vietnam's coastal and marine ecosystems

The coastal zone of Vietnam supports a wide variety of ecosystems and high biodiversity. While there is not a single way to categorize them, the *natural* coastal and marine ecosystems of the coastal zone of Vietnam include mangroves, swamplands, beaches, dunes, tidal flats, lagoons, coral reefs, seagrass beds, and islands. The area of these ecosystems has been estimated at ca. 10,960 km^2 (MONRE, 2006). These ecosystems harbor more than 11,000 species including nearly 2,500 species of fish (130 of which are of high economic value), 225 species of marine shrimps, 635 species of seaweeds, nearly 400 species of corals, 94 species of mangrove plants, 14 species of sea-grass, 43 species of waterfowl, 6,000 species of zoobenthos, and 1200 species of zooplankton and phytoplankton (VACNE, 2004).
An overview of the main coastal and marine ecosystems in Vietnam is provided below.

Coral reef ecosystems: The geographical and climate conditions of Vietnam's sea areas are generally favourable for coral reef formation. Coral reefs are mainly found in near-shore shallow waters; however the distribution patterns and types of coral reefs are different in different geographical regions. There are ca. 1300 km^2 of coral reefs in Vietnamese waters, concentrated in the Paracel and Spratly archipelagos and Central coastal waters. Approximately 2,000 species of benthos, fish and other aquatic beings live in the coral reefs. (Vo Si Tuan et.al. 2005)

Mangrove ecosystems: This type of ecosystem develops well in the areas of river estuaries and coastal lands in the North and the South. Before the wars (1943) the total mangrove area in Vietnam was about 400,000 ha with primary and dense forests (Hong et al., 2007). The massive destruction of mangroves due to the wars together with human impacts drastically reduced the mangrove area. With recent and ongoing efforts to mainten and recover mangrove forests, Vietnam had some 156,608 ha of mangrove,

including secondary and replanted forests, as assessed in 2001 (Sam eds., 2005). About 94 species of mangrove plants are found.

Seagrass bed ecosystems: In Vietnam, 14 species of sea grass belonging to 4 families, 9 branches have been identified with a total area of about 16,000 ha. Sea grass is mostly allocated to coastal estuaries in tidal areas of up to 3-6 m depth - sometimes up to a depth of 20 m. They are found abundantly in the territorial waters of Quang Ninh, Hai Phong, Nam Dinh, Thua Thien Hue, Khanh Hoa, and Da Nang provinces as well as Con Dao and Phu Quoc islands.

Lagoon ecosystems: Lagoon ecosystems are located mainly along the Central Coast (from Thua Thien Hue to Ninh Thuan province) with a total area of about 447.7km^2. This region has a complex topography that is prone to coastal erosion which enables lagoon formation. Lagoons in Vietnam usually have a flat bottom, a depth range of 2-4m, and a water salinity range of 1-32%, depending on the rain regime (wet or dry season)(Do Cong Thung, 2004).

Tidal flat ecosystems: Due to large tidal amplitudes (over 4m), tidal flats are usually long and wide in the Gulf of Tonkin and along the south-eastern coast. These two areas represent tidal ecosystems. Tidal flats are usually divided into 3 zones: high, medium and low tidal zone, each of them hosts particular ecosystems. (Do Cong Thung, 2004)

Beach ecosystems: Hundreds of beaches are distributed along Vietnam's coast. In the North, there are over 100 beaches in the Ha Long – Cat Ba – Do Son area. Famous beaches of the Central Coast with fine white sand include Sam Son, Cua Lo, Da Nhay, Lang Co, Nha Trang. There are about 16 white sand beaches around Van Phong – Dai Lanh which is a strategically important bay area on the central Coast. Large beaches are also found around islands such as Con Dao and Phu Quoc. (Do Cong Thung, 2004)

Island ecosystems: Vietnam has more than 3,000 islands and islets. Many of them are concentrate in the territorial waters of Quang Ninh province in the North forming the World Natural Heritage sites of Ha Long Bay. Some large islands on the Central Coast and in the South such as Cu Lao Cham (Quang Nam), Phu Quoc (Kien Giang), Tho Chu (Kien Giang), and Con Dao (Ba Ria – Vung Tau) are characterized as unique ecosystems with endemic species. Islands near the shore of Vietnam are usually low mountains with rather flat peaks, mainly having tropical flora and fauna. (Do Cong Thung, 2004)

1.2. Poverty within the coastal zones of Vietnam

Poverty in Vietnam

A variety of poverty and social development indicators are currently used in Vietnam. The Ministry of Labors, Invalids and Social Affairs (MOLISA) uses a methodology based on household income. The current MOLISA poverty lines (Center for International Economics, 2002) include VND 80,000 (USD 5) per month in rural mountainous and island regions, VND 100,000 (USD 6.25) per month in rural plain areas, and VND 150,000 (USD 9.38) per month in urban areas. Households are deemed poor if their income per capita falls below these conventional thresholds that vary between urban, rural, and mountainous areas.

The General Statistics Office (GSO) relies on both income and expenditures to calculate a poverty rate. It defines a threshold based on the cost of a consumption basket which includes food and non-food items, with food spending being large enough to secure 2100 calories per day per person. Households are considered poor when their income or expenditure level is not high enough to afford this consumption basket.

Based on the expenditure method, the World Bank's *Vietnam Development Report 2004 - Poverty* indicated that in 2002, 29 percent of the population was poor in Vietnam compared to 37 percent in 1998 and 58 percent in 1993. It was a remarkable accomplishment that the poverty rate was literally halved in less than a decade. It was also noted that poverty has a strong spatial (or geographical) dimension in Vietnam. In terms of percentage, the Central Highlands and the Northern Mountains are the poorest regions in the country, followed by the Central Coast (both North and South). However, in terms of density, the two deltas (Red river and Mekong river) and the Central Coast are the regions with highest absolute numbers of poor (Poverty map - IFPRI and IDS, 2003).

People and poverty in the coastal zone

The coastal districts of Vietnam have a population of about 18 million people (MONRE, 2006), accounting for nearly 22% of the total population of the country (GSO, 2006). As the area of the coastal districts accounts for only 16% of the total area of the country, the population density in the coastal districts is obviously mush higher than the national average.

In general, the poverty rate in coastal regions is lower than that in Vietnam's mountainous interior. Unlike the mountainous regions, the economies of coastal regions are more diverse, which in turn results in a more diverse labor force, including a variety of skilled and educated workers (T T H Nhung, 2007). Despite this, coastal economic development has heavily depended on marine and coastal resources that are vulnerable to natural disasters, overexploitation, pollution, and other threats.

Within the coastal zone, a poverty research report authored by the International Food Policy Research Institute (2003) shows that the Central Coast is the poorest region at the provincial scale. Amongst 28 coastal provinces of Vietnam (see Annex 2), only the city of Da Nang has a poverty rate under 20%. The Central Coast also has the two provinces with highest poverty rate: Quang Tri – 51% and Ninh Thuan-53%. Coastal provinces of the Mekong River Delta are the least poor coastal region thanks to the contribution of Ho Chi Minh City and Ba Ria – Vung Tau.

At the district level, it comes to the attention of the research team that data and information on poverty status is very limited. Only one study (IFPRI and IDS, 2003) provides the poverty status down to district level details. It indicates that among 126 coastal districts (including 116 districts having coastline and 10 island districts), 60% of them (76 districts) had a poverty rate above 37% which was the average poverty rate of the country at the time. It is also noted that at the district scale, rural coastal areas are substantially poorer than the urban coastal areas. In Hai Phong for instance, urban districts of Le Chan, Hong Bang, and Kien An have poverty rates of less than 7 % as opposed to at least 20% poverty rate in rural areas. This pattern holds true in all other provinces.

In general, coastal population livelihoods are quite diverse, including fisheries, agriculture, livestock husbandry, handicrafts, salt panning, etc; however 80 % of households among Vietnam's coastal communities get their income from fishing, whilst almost all livelihoods rely on fish capture and associated activities as coastal communes commonly have little agricultural land. Fishers' livelihoods are vulnerable to seasonal weather, destructive typhoons, and migration (DFID, 2002). In the other words, the coastal communities are heavily dependant on and highly vulnerable to changes in the status of the coastal resources and related coastal ecosystem services. Among poor people living in the coastal areas, many are engaged in small-scale fishing, agriculture farming and salt production.

It is recognized that the link between poverty, the coastal environment and ecosystem services is strong. The poor are becoming more venerable and becoming more seriously affected by coastal disasters such as floods, typhoons and the consequences of climate change in the coastal zone of Vietnam.

1.3. Conceptual framework (MA)

This country's situational analysis is taken through a knowledge assessment and stakeholder consultation adopting and adapting the conceptual framework developed by the Millennium Ecosystem Assessment. The framework is presented in Figure 1, which shows how coastal and marine ecosystems provide a range of ecosystem services (classified as supporting, regulating, provisioning and cultural) which in turn may bring benefits to poor people. Interventions may potentially enhance the flow of ecosystem services to enhance benefits accruing specifically for the poor. In turn capturing the values of ecosystem services may affect the way people manage ecosystems and hence their potential to deliver services.

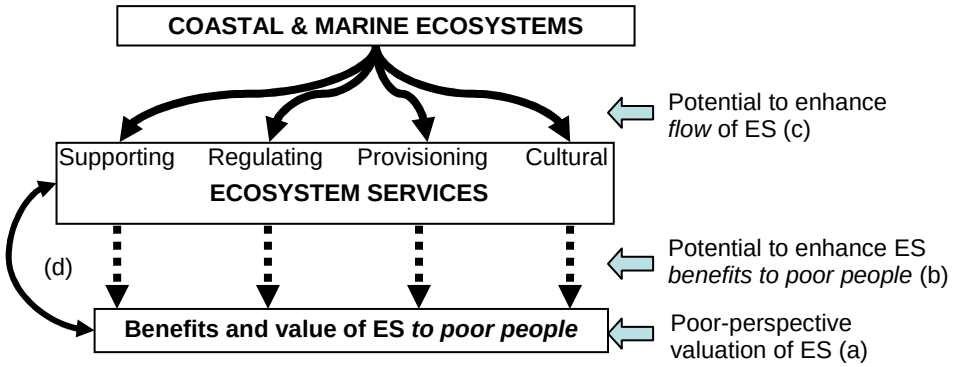

Figure 1: Linking Ecosystem Services and Poverty Alleviation

Using this framework, the Vietnam situational analysis will examine three dimensions of the relationship, including: (1) the status and condition of ecosystem services and their benefits for human well-being; (2) the changes in ecosystem services including management and policy response options, and; (3) key challenges, critical gaps in knowledge, and strategies to address them.

II. COASTAL AND MARINE ECOSYSTEMS WITHIN VIETNAM

Chapter 1: Coral Reef

There are ca. 1300 km^2 of coral reefs in Vietnamese waters, concentrated in the Paracel and Spratly archipelagos and Central coastal waters. Of this, ca. 180 km^2 are on the peninsular coast; the rest are associated with the offshore islands. On the coast, most reefs are concentrated in Quang Ninh, Hai Phong, Hai Van- Son Cha, Cu Lao Cham, Ly Son, Khanh Hoa, Ninh Thuan, Con Dao and Kien Giang, with other areas having unremarkable coral coverage (Figure 2). All coral reefs in Vietnam's coastal areas are fringing and platform reefs (Vo Si Tuan, 2000a,b) while atoll reefs can be found in Spratly and Paracel islands (Ngai, 2004). These reefs comprise some 400 species of coral and provide habitat to some 2,000 species of benthos, fish and other aquatic marine organisms. (Vo Si Tuan et.al., 2005).

A regional study of valuation of South China Sea coral reef systems (UNEP/SCS 2007) demonstrates the dearth of available information on the valuation of Vietnam's reefs (Table 1). While the valuation for Vietnam is low relative to other countries in the region, the only value included is that for reef-tourism; currently a fairly minor component of the services provided by the country's reefs. No valuation for goods, most notably fisheries, is included.

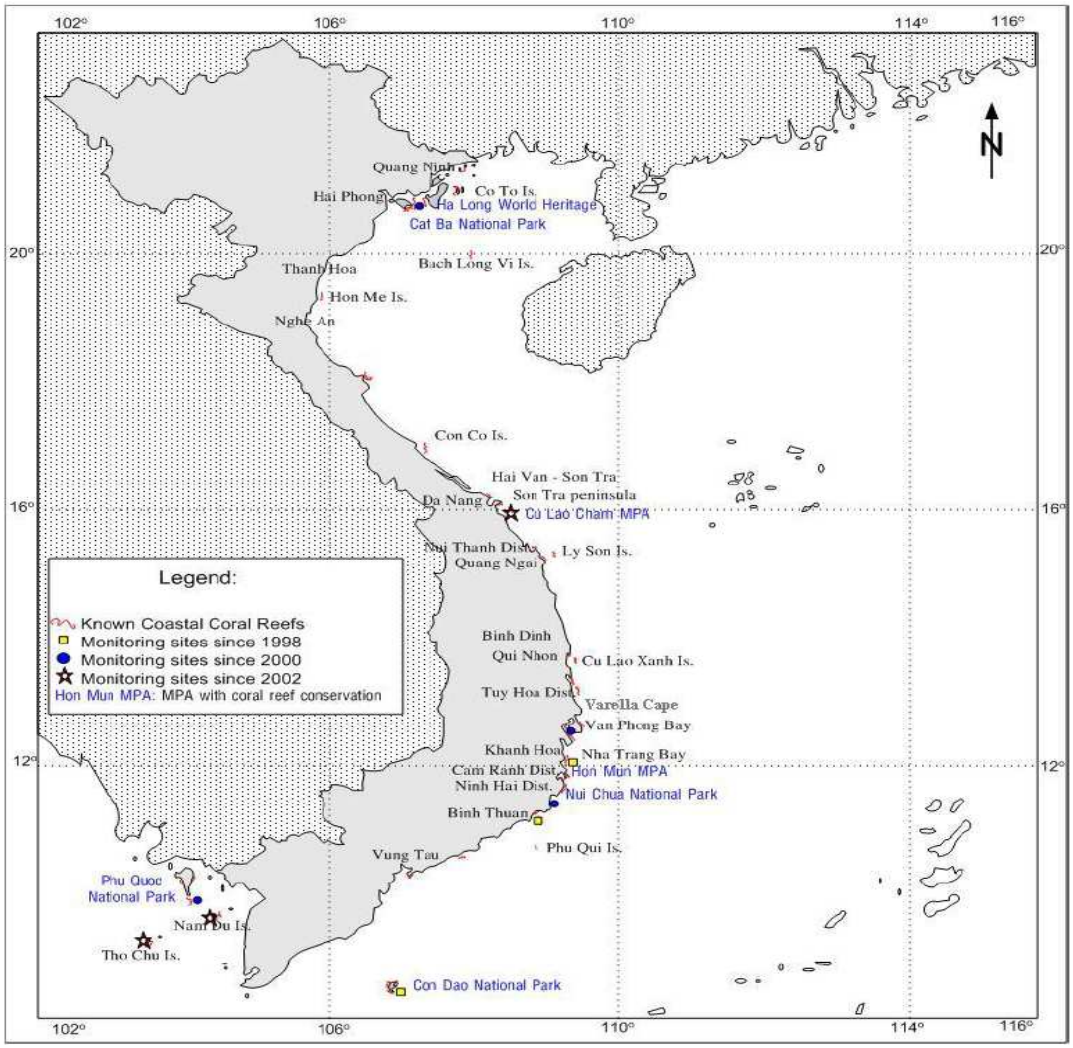

Figure 2: Distribution of coral reef on peninsula coast

Table 1: Weighted mean national and regional values for the annual production of goods and services by coral reefs bordering the South China Sea Source: UNEP/SCS, 2007

	Cambodia	Indonesia	Malaysia	Philippines	Thailand	Viet Nam	Regional
Coral Reef Goods							
Capture Fisheries (food and aquarium fish)	0.00	285.49	0.00	150.98	0.00	0.00	108.31
Shrimp	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shellfish collection	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Molluscs	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sea Cucumbers	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Echinoderms-Sea urchins	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coral - Building materials m3	0.00	482.81	0.00	0.00	0.00	0.00	25.28
Coral (curio trade)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seaweed	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Value Goods US$ per Ha	0.00	768.30	0.00	150.98	0.00	0.00	133.59
Coral Reef Services							
Coral Reef Tourism	0.00	0.00	0.00	270.19	7,149.70	964.17	1,024.62
Research	0.00	0.00	0.00	0.00	0.00	0.00	
Beach Protection	0.00	7,330.56	0.00	0.00	0.00	0.00	383.80
Biodiversity Option Value	0.00	10.57	0.00	0.00	0.00	0.00	0.55
Total Value Services US$ per Ha	0.00	7,341.13	0.00	270.19	7,149.70	964.17	1,408.97
Total Value Goods and Services US$	0.00	8,109.43	0.00	421.17	7,149.70	964.17	1,542.56
Total coral reef area in the South China Sea (ha)	2,807	39,287	44,276	464,000	90,000	110,000	750,307
Value of Annual Total US$	0	318,595,042	0	195,422,880	643,473,000	106,058,248	1,157,393,756

1. Assessment of ecosystems and linkage with poverty alleviation

Provisioning services

(a) Capture fisheries
Reefs in Vietnam support a large number of (often high-value) fish and crustacean species, providing livelihood support and food through a diverse range of fishing activities (table 2). Data on reef-associated capture fisheries, both commercial and subsistence, is very limited. Reef species are not disaggregated from other marine species in national government statistics.

Table 2: Main fishing activities and marine resources collected from coral reefs in Vietnam

Fishing activity	Main Marine Organisms Fished
Hookah air diving with or without dynamites and poisons	Groupers, sweetlips, top shells, triton shells, giant clams, lobsters, ornamental fish and live corals
Net (gill net, purse seine, drift net)	Sweetlips, snappers, cardinalfish, coral breams, anchovies
Light fishing	Anchovies and cuttlefish
Long line	Cuttlefish and fish
Fixed net	Mackerel, tuna, snapper, jacks
Trap net	Cuttlefish and fish
Gleaning on tidal flat	Seaweeds, gastropods and fish

Source: Vo Sy Tuan et al, 2005

A small number of case-studies provide some insight into the potential direct production and value of reef fisheries in areas with significant reef area. Data from a case study in Ninh Thuan (Vo Si Tuan ed., 2007) in the central coast region, shows that the strongly reef associated grouper *Epinephelus sp.* accounted for some 10% of a total catch of demersal fish in the province. The annual catch of adult lobsters harvested from the coral reefs ranged between 30-50 tones with the price ranging from 200,000 – 300,000 VND (US$12.40 – $18.60) per kg. Production of giant clams collected around Con Dao islands reached 10 tones during April-July of 1994. In 2001 there were some 4 tones of gastropod and bivalve shells exported to Nha Trang and Da Lat.

Reef around the off-shore island, Nam Yet, support 2128kg of commercial fish per ha, (Quan NV 2007 - 2008) with a value of ca. 170,000,000 VND (ca. $10,000USD). Quan (2007-2008) reported 206 fish species living on Con Dao's reefs, among them 61 were commercial species and 108 were ornamental or aquarium fish. The study also identified 21 crustacean and 54 mollusk species of commercial value..
In a further case-study, there were 178 coral fish species found in Cu Lao Cham reef (WWF 1994)

(b) Genetic sources:
Coral reefs are rated as the highest biodiversity ecosystems of the world, and the reefs of SEA region are the highest amongst all coral reefs (Table 3). There are 1206 species of reef fish and more than 1000 coral dwelling species having close relationships with coral reefs (Quan et al., 2006). In recent years, several coral reef species have been discovered, some of which are now listed in Vietnam's Red Book and the IUCN's red list of threatened species.

Table 3: Diversity of fish species on the coral reef

	Marine Fish Species Diversity	Hard Coral Species Diversity
South East Asia	2,500	400-500
Great Barrier Reef	1,500	395
Caribbean	500-600	100-200

Source: Vo Sy Tuan ed., 2007

(c) Biochemical, natural medicines and pharmaceuticals
Biochemical research on reefs is relatively new in Vietnam. According to the studies cooperatively undertaken by the Institute of Marine Environment and Resources and the Institute for Natural Chemistry Compounds, several soft corals and sponges in Vietnam contain molecular compounds that may be used to produce drug tablets to treat cancer related illnesses (Chau Van Minh et al, 2004).

(d) Construction materials
Dead corals and coral rubble located in the nearshore zone have been used for cement and slakes lime processing. This contributes to coastline erosion and affects other marine resources through the removal of critical habitat for settling larvae of several species such as lobster, a species of high economic value in the aquaculture sector.

Regulating Services

Shoreline protection
Coral reefs are considered as 'sea dikes' that protect coastlines and islands from erosion. Wave energy is reduced when passing the coral reef in proportion to the width and altitude of reef (Kench and Brander, 2006). Shoreline protection values of the coral reefs are clearly seen in marine area in the central provinces of Vietnam including Bai Tien and Hon Khoi, Khanh Hoa province, although there has been no direct valuation of the protective roles of reefs. Recent coastal erosion has eliminated 30% of the total area of floating islands including some residential areas (Vo Sy Tuan et al, 2005). The annual cost for construction and maintenance of dikes to protect these areas is extremely high and is at least in part attributable to the loss of reef. Vietnam is listed as one of the five countries in the world to be worst affected by the serious impacts of climate change. Scientists predict the sea level may rise 1m in the next 100 years (Dasgupta et al., 2007) and it wil effect more than 10% of population. Scientists predict the sea level may rise 1m in the next 100 years. According to the United Nations, if this occurs, Vietnam will face losses of up to US$17 billion a year. Around one-fifth of the population will lose their homes while 12.3% of cultivated land will disappear. A total protection strategy against 1m sea level rise involving dike enhancement, additional pumping, and beach nourishment will cost USD 9 billion (Huan NN, 1997).

Cultural Services
(a) Tourism
Coral reefs play an increasing role in Vietnam's tourism industry. The major recreation activities on reefs are snorkeling and scuba. Nha Trang City, for example, is one of the first marine tourism centers in Vietnam, showcasing its very diverse and abundant coral reefs surrounding the nearby islands. The number of visitors to Nha Trang is increasing (30,000 people in 1995 and 400,000 people in 2003). About ten percent of these vistors participated in diving and snorkeling on the reefs of Hon Mun MPA. These services brought a benefit about US$400,000 and accounted for approximately 2% of the total revenue from the tourist sector in Khanh Hoa province.

Phu Quoc (Kien Giang) and Cu Lao Cham (Quang Nam) are now promoting tourism on their coral reefs. An Thoi Island, with pristine coral reefs, has been considered for diving, snorkeling and fishing activities by tourism outfits, although currently there is only one operator.

Supporting Services:
(a) Island/beach creation
Several offshore islands such as Hoang Sa and Truong Sa archipelago located in the South China Sea were created by the build up of dead coral sands and rubble. Many popular swimming beaches found in Ha Long and Cat Ba are related to the marine depositional regimes associated with the coral reef production.

(b) Habitat
Coral reefs are a critical nursery habitat for numerous marine species, and constitute important near-shore fishing grounds. Grouper, commanding a high price in the live food fish trade, often aggregate to spawn at the reef slope in the breeding season (Saldovy, 2001).

It is widely held that the reefs associated with the offshore islands function as a larval source for many areas in the South China Sea (e.g. McManus 1994). It has also been suggested that the Spartley Islands are a likely source of the seed collected for lobster culture along the central coast of Vietnam (Williams 2004). In recent years, the value of this industry has been estimated at US$50-60 million per annum.

Seed harvesters have captured in excess of 1 million pueruli (first post-larval stage) in some years, which are sold to dealers for up to US$10 per individual, depending on species and current demand for seed from farmers.

(c) Primary production
The reef ecosystem plays a vital role in joining marine food web as they are areas of high productivity in what is generally a nutrient-poor environment (Castro Hubley, 1997).The zooxanthellae living symbiotically inside the coral skeleton provide much of this production through photosynthesis.

Economic Value of Vietnam's coral reefs

Based on the study carried out by Pham Khanh Nam in 2005 to assess the valuation of coral reefs in Hon Mun marine protected area (Table 4)with the quantitative data as follows:

Table 4: Net present for economic value of the Hon Mun MPA in $US

Present Values (in US$ million)	Tourism benefit	Fishery benefit	Conservation benefit	Total Benefits	Costs	NPV
'With management' options	44.30	25.50	2.88	72.68	2.37	70.31
'Without manage-ment' options	30.47	23.64	0.00	54.12	0.22	53.89

Source: Pham Khanh Nam et al., 2005

The net present value of the Hon Mun area over the period 2005 – 2015 is US$70.3 million under the 'with management' scenario and US$53.8 million under the 'without management' scenario.

2. Trend dynamics of ES (changes)

2.1. The change of Ecosystems and ES

More than 200 coral sites have been surveyed along Vietnam's coast over the last 10 years. Based on the ranking system used by English *et al* (1997), only 1% of coral reefs are in good condition (>75% live coral cover), while more than 30% of coral reefs are in bad condition (<25% cover). Coral reefs assessed as having average or better coverage comprise about 41% and 26% of Vietnam's reefs respectively. The specific survey data for each coral reef indicates that the average cover ranges from 25 to 50%. Those coral reefs located offshore or far from human settlements often remain in relatively good condition; however, the coverage of live corals on the reefs at some major distribution areas of Vietnam waters has been decreasing over time. The coral coverage has declined to 30% in some areas (Table 5). The general trend is towards wide scale coral reef degradation.

Table 5: Coral cover decline in key reef sites in Vietnam

No	Study site	No of sample stations	Percentage of decline in coral cover (%)	Interval
1	Ha Long-Cat Ba	22	-21.3	1993 - 1999
2	Cu Lao Cham	5	-2.7	1994 - 2004
3	Nha Trang bay	8	-31.2	1994 - 2005
4	Con Dao	8	-32.3	1994 - 2002
5	Phu Quoc	5	-7.8	1994 - 2004

Source: *Vo Sy Tuan et al., 2005*

Generally, live coral cover is highest far from urban areas, industrial zones and terrestrial run off, and in areas where there is less destructive fishing. Some results from coral cover surveys conducted by Vo Si Tuan (2007) occuring from 1999 to 2005 are show in Table 6.

Table 6: Status of coral reef cover in major coastal areas of Vietnam

TT	Study sites	No. of sample stations	Average live coral cover (%)	Last study year
1	Ha Long - Cat Ba	22	25.7 ± 15.2	1999
2	Bach Long Vy	5	21.7 ± 19.0	1995
3	Hai Van - Son Cha	7	50.5 ± 15.7	2004
4	Cu Lao Cham	15	21.2 ± 16.6	2004
5	Nha Trang Bay	8	21.1 ± 19.6	2005
6	Ninh Thuan	6	36.9 ± 13.5	2002
7	Ca Na	6	31.7 ± 23.5	2003
8	Con Dao	8	23.3 ± 18.2	2002
9	Phu Quoc	7	37.8 ± 6.1	2004
10	Nam Du	2	37.0 ± 0.2	2005
11	Tho Chu	4	29.4 ± 21.2	2005

Source: Vo Si Tuan ed, 2007

Box 1. Coral reefs at risks

- **Among 1300km² of coral reefs distributed along the coast of Vietnam only 1% are in good condition**
- **Coral coverage has declined down to 30% in some areas since 1993-2004**
- **General trend is towards wide scale coral reef degradation.**

2.2. Drivers of change in reef systems

Over fishing: Over-fishing is endemic throughout the coastal waters of Vietnam, and is particularly marked on coral reefs due to the high market value of many reef-dwelling species. In extreme cases this has resulted in local extinctions of species (eg. lobster in Cat Ba, abalone in Co To). Many species such as clam, abalone, groupers, and tiger shrimp are caught to satisfy the demand of specialty sea food restaurants and exporters. Young fish are captured for cage culturing (grouper and lobster), meanwhile fish of low economic value are exploited as trash fish for cage culture species. Over exploitation has exhausted some keystone species (Triton snail, top shell, predatory and grazing fish) causing trophic cascades which lead to algal blooms and starfish 'plagues' in areas such as Co To, Hon Mun, Con Dao (Chung BD, 2000). A critical example of reduction of the CPUE for grouper fish was assessed in Co To islands. In 1990s, Co To played as the important fishing ground for live reef fish trade while grouper fishes were main targets (CPUE = 5kg per labor/a diving day). However, 2003's surveys showed most of the divers abandoned this fishing technique because it seems that no more groupers occurred at the surrounding waters of Co To (Quan NV and Phuong LD, 2003).

Given the high value of reef associated species in general, it is likely that the subsistence value of reef fisheries has declined rapidly with market development (national and international) and the livelihood value has increased, although to a lesser degree due to the reduction in fish stocks.

Destructive fishing methods: Due to decreasing catch-rates with traditional and leagal fishing gears, some fishermen have turned to highly effective but destructive gears such as electrified nets, small mesh nets, cyanide and mines (dynamite fishing). Experiments conducted in Vietnam (Yet NH 1999) using fish caged at 1m intervals from a blast site demonstrated that the use of a single 'mine' would kill fish in a 10m radius, and destroy 4 m^2 of coral. The value of live reef fish has in some places reduced the prevalence of dynamite fishing, this being replaced with either line fishing or cyanide fishing (McCullough and Phung, 2001). The combination of using SCUBA equipment and cyanide to catch rare species such as grouper and seabass depletes reefs at a rapid rate. This method is common in Co To, Bach Long Vy and Ly Son (Quan NV, 2007-2008).

Coral harvesting: Coral exploitation occurs in Halong, Cat Ba, Nha Trang, and Ninh Thuan for ornamental/souvenir purposes. In Ca Na coral and coral rubble are sold along the road-side. In Dam Market, Nha Trang, coral colonies with variety of shapes are made and sold with more profits. Boats fulfilled with coral rock extracted from Cat Ba and Ha Long dock regularly in Ben Binh (Hai Phong). Coral rock is also harvested for processing into construction materials (eg. lime burning (Hon Khoi, Nha Trang), road construction, sea dikes around off shore islands.

Anchoring of fishing and tourist boats also causes damage to many reefs such as Ha Long, Cat Ba, Hun Mun, Con Dao, and Ly Son. Physical damage from anchors and especially boat groundings can be severe. Anchor damage is proportional to the size of the boat (weight of the anchor and length of anchor chain).

Water pollution is a major threat to coastal reefs, especially adjacent to industrial zones and urban areas. This effect can be seen at Ha Long and Cat Ba where tourists, dense urban and industrial development, and coal mining all contribute to the pollution load which has a strong effect on the coral health of the area. High turbidity and eutrophication are recorded in the rainy seasons - sometimes reaching more than ten times the maximum limits of tolerance. Many coral reefs near run-off sources have been killed.

Climate effects: Abnormaly elevated sea surface temperature, likely due to climate change, has killed many coral reefs, especially in southern Vietnam. Vo Si Tuan (2000) demonstrated that coral cover in Con Dao was reduced by about 37% due to the bleaching caused by the 1998 El Nino event. Although most coral in the North were not affected by this bleaching event, some closed reefs were also killed in shallow waters in 2003.
Tropical storms have the potential to cause damage to coral reefs, particular for open reefs, through high energy wave action that can physically damage coral in shallow water. The level of the damage following major storms can be severe, and depends on reef morphology. The damage from storm waves can be more serious if the reef is dominated by branching or staghorn coral. Surveys carried out following a tropical storm in Cat Ba, Ha Long and Long Chau in 2006 showed that wave energy can break coral colonies in depths of up to 8-10m. Similar results were observed in Con Dao in 2006 and Cu Lao Cham in 2007.

Sedimentation: heavy rain in a short time leads to an overload of fresh water run off accompanied by erosion on bare lands resulting in sediment choking of reefs near river mouths and adjacent to the mainland. This phenomenon was recorded in Ha Long and Cat Ba during 1998-1999 (Yet, 1999, Ngai ND, 2004) and about 20-30% of the reef area was lost. Additionally, human activities such as coal mining, marine transportation and waste water all contribute to high turbidity and sedimentation in coral reef areas.

Predators and disease: Crown of Thorn Starfish (*Acanthastrea planci*) outbreaks have caused damage to many reefs in the south of Vietnam. In 2002-2003, 50 starfish/ha were observed in Cu Lao Cham's reefs, while in Van Phong bay 150 starfish/ha were observed and Nha Trang saw 60 starfish/ha (Vo Si Tuan et al., 2002). Even on offshore reefs such as those near Nam Yet Island 50ind/ha were observed and reduced live coral cover by 20% in one year alone from 2006-2007 (Ngai, 2007).

Outbreaks of the snail *Drupella* were remarkable in Cat Ba and Ha Long Bay. Fourty ind/m^2 was observed and 20% of substrate component was recent killed coral (Ngai 2006). White band and pink diseases were also recorded on reefs in Ha Long and Cat Ba, however the number of diseased colonies were few.

3. Links with poverty alleviation

3.1. Contribution to well being and the lives of the poor

Material minimum for a good life
Coral reefs serve as daily fishing grounds for coastal fishermen. Healthy coral reefs are productive ecosystems and provide a steady flow of income and nutrition to fishers. Conversely, reefs in poor condition may exhibit low marine productivity meaning that fishers have to spend more money for fuel and more effort fishing, which directly impacts their income and material well-being. However coral reefs are open access and common property resources. Under weak management by the local authorities, many fishers try to catch fish by any methods available provided that they can catch more fish for less cost and effort. Due to low awareness of the impact of their activities they often harm coral reefs, reduce the natural resources they depend on and, as a consequence, increase the expenditure required to catch the same amount of fish day after day. Many fishermen shift to other offshore capture or other livelihoods, but this often results in little improvement in material well-being due to a lack of experience and knowledge needed for new livelihoods.

An example of this is at Co To archipelago which, with a width and length several kilometers, was considered the largest coral reef in coastal northern Vietnam and was rich in natural resources. This area is a major fishing ground for Quang Ninh fishers and fishers of other coastal provinces. Many destructive fishing methods were commonly applied here such as mines, diving with cyanide poison, and electrical gun fishing. Today, nearly all the coral at this reef is dead, marine resources are drastically decreased and many fishing divers have lost their job and become unemployment.

Ly Son Island (Quang Ngai province) was formed through volcanic processes and is suitable for coral development due to its hard sea floor and gentle slope. However, there are hundreds of diving boats that operate daily around the island. Damage from divers who step on and grap corals are the main cause of coral degradation. In addition, cyanide and electrical gears are also applied to catch fish. Initially each fishing diver could earn 100-200 USD per day. Due to this high potential income and low cost, many other fishermen became divers without training or licenses. Now fishing grounds have expanded to the Spratly archipelago, Malaysia, and the Philippines; however the high risk of this work makes many divers give up their job. Several divers have died under water, and some other have became the handicapped.

Good social relations
The introduction of the MPA based co-management concept in terms of community-based coastal resource management in recent years has attempted to bridge the gap between resource use and stewardship. People living in communities where MPAs are located often receive benefits from alternative livelihood programs run by the government. They care more about the natural resources of their locale than other people at the outside MPA (Angus McE, et al, 2008).

3.2. Issues of access to the benefits of the ES by poor people

Angus McE et al (2008) examined the strengths, weaknesses and threats facing coastal communities living near coral reef ecosystems in Vietnam.

Strengths	**Weakness**
- Relative abundance fisheries resources and biodiversity - Tourism potential - captive and increasing tourism market - Labor – cheap, healthy - Harbors located for provision of services to offshore fishing and cargo vessels - Comparative advantages in the local market - Social cohesion and strong community ties	- Storms, typhoons, strong winds restrict activities - Isolation from mainland markets – comparative disadvantage - Isolation from mainland services and information - education, health, etc - Inadequate infrastructure and services – electricity, water, waste treatment - Relatively unskilled and non entrepreneurial labor force - - Limited range and amount of local inputs for production – limited options and economies of scale
Threats - Ongoing depletion of marine resources and declining incomes - Pollution – solid waste, sewage, oil spills, ballast water - Unplanned tourism development that does not benefit the local communities - Storms and typhoons - Climate change and sea level rise - - Social impacts of harbors and itinerant populations of men	

4. State of knowledge and gaps

Although studies on coral reefs in Vietnam have been undertaken for many years, the understanding of coral reefs is still limited. Most of the studies have focused on coral reef taxonomy, while a few studies have focused on the quantitative linkages between the impacts of human influenced reduction of ES quality that directly contributes to human wellbeing.

The linkages between ES and human wellbeing can be understood as the consequences of negative impacts from human driven activities. In fact, poor people (fishermen) will be most affected due to of loss capital resources and the lack of technical skills needed in order to change livelihoods.

5. Tradeoffs

5.1. User conflicts

5.1.1. Subtractibility of the ES benefits
As discussion in the above section, reduction of the ES will directly affect the income of many local people causing increased vulnerability and social security concerns.

5.1.2. Impacts on ES of human activities
While local fishers want to encourage economic growth for poverty alleviation, they are often forced to exploit natural resources in such a manner that breaks down the ecological balance of the ecosystems they depend on (eg. reducing species diversity) which impairs proper ecosystem funcioning and works against sustainable economic growth.

5.1.3. Poor-Rich, Men-women, Ethnic/class conflicts
In rural areas, especially the offshore islands, men have more opportunity to receive formal education than women because the traditional culture of Vietnam still considers men as the grassroots of a family. A problem inherent in poverty alleviation is that rich people always have more opportunities to get richer. For example, rich people can invest more in services such as tourism and industrial works while poor

people often do not have the required skills and capital investment. There are some gaps and overlaps among the laws to meet the local people demands. In addition, the complaint that "the city people make laws which the rural people are forced to follow" should be addressed in order .to find acceptable common legal ground.

Gender issues: there are differences between men and women in the procedures used to assess the ES provided by coral reefs. As stated previously, 80% of the local coastal population is involved in the capture fishery as their primary employment due to the lack of the agricultural land. Men are normally engaged in fishing activities about 20 days per month, and work hard to earn their living. If they fish near shore, women may accompany them as crew members; however in general women spend most of their productive time caring for the children and households and selling fish products. Thus their living depends on the men. On average, each household is comprised of parents, grandparents and 4-6 children living in the same house (Nguyen Van Quan, 2003). At the community level, men also take part in more social activities than women; they therefore build strong social relationships among a broader spectrum of stakeholders. At the family level, men get more opportunity for education, training and acquiring knowledge than women. Consequently, women in the fishing community have less access on resources sharing of ES vis-à-vis men. There are two types of fishers: wealthier people who have money to build fishing boat (these tend to receive more benefits) and free labor fisher (who join the boat as crew members (these tend to earn only enough for a modest living). In recent years, the Vietnam government has tried to fill the gender gap in the coastal areas through several policies such as more training courses open for women to set-up small businesses at home and Women's Unions who support poor families through credit channels to create more varied livelihoods in order to reduce the exploitative pressures on the natural resources.

5.1.4. Regional-local

There appears to be poor balance of the benefits received from ecosystem services among different reef-using groups. A typical example comes from Nha Trang where the government only invests 10% of the total entry fee collected at the Nha Trang Bay marine protected area back into local community development project. Most of the benefits accrue to the people who operate the tourist services and live in the city (Bernard, 2008).

Box 2. Inequality of benefits of ES among users

- **The rich get higher incomes through the exploitation of the ES while the poor have fewer chances to increase their income**
- **Inequality of the sharing of benefits: only 10% of the benefits acquired from ES exploitation has been invested on the local community development**
- **A big gap between policy makers and the local fishers in terms of "The people living in city makes law for people to live in the rural area"**
- **How can people to deal with conflict issues?**

5.2. Societal goals

5.2.1. Long-short term tradeoffs

Exploitation of corals to sell as souvenirs, lime burning and fishing down the food chain may bring instant benefit for the local fishers but causes long term harm to the habitats of coral dwelling species.

5.2.2. Poverty alleviation vs economic growth, ecosystem and biodiversity conservation and cultural values

As discussed previously, economic growth can create many positive outcomes for poverty alleviation may increase in following years. However it is hard to balance the benefits from strategic economic developments with the conservation of coral habitat. In recent years, high intensity industrial development in the coastal zone may cause serious harm to the biodiversity of the coral reefs in Vietnam.

Chapter 2: Seagrass Bed

Fourteen species of seagrass are distributed from the North to the South and occur in coastal estuaries and around islands at a depth of 0-20m. *Halophila* communities are the most common with two species of *Halophila* growing along this coastline. Northern *Zostera* extends down as far as the latitude of Quang Nam province. *Thalassia hemprichii*, *Cymodocea serrulata*, *Enhalus acoroides* and *Halodule uninervis* grow in a wide range of habitats and are the dominant species in terms of occurrence and area from Khanh Hoa to Kien Giang province. Other species such as *C. rotundata, H. pinifolia, Syringodium isoetifolium* occur in small patches in the South of Vietnam. In total 16,000 ha of seagrass occur along the coast (Vietnam Seagrass Committee (VSC), 2004; Tien et al 2006). The largest areas occur in the shallow waters of Phu Quoc island (more than 10,000ha) where there are 9 species (Tien et al, 2006) followed by the Thuy Trieu lagoon, Khanh Hoa province (800 ha) and Phu Qui island (300 ha) as well as in some estuaries in Central Vietnam (VSC, 2004).

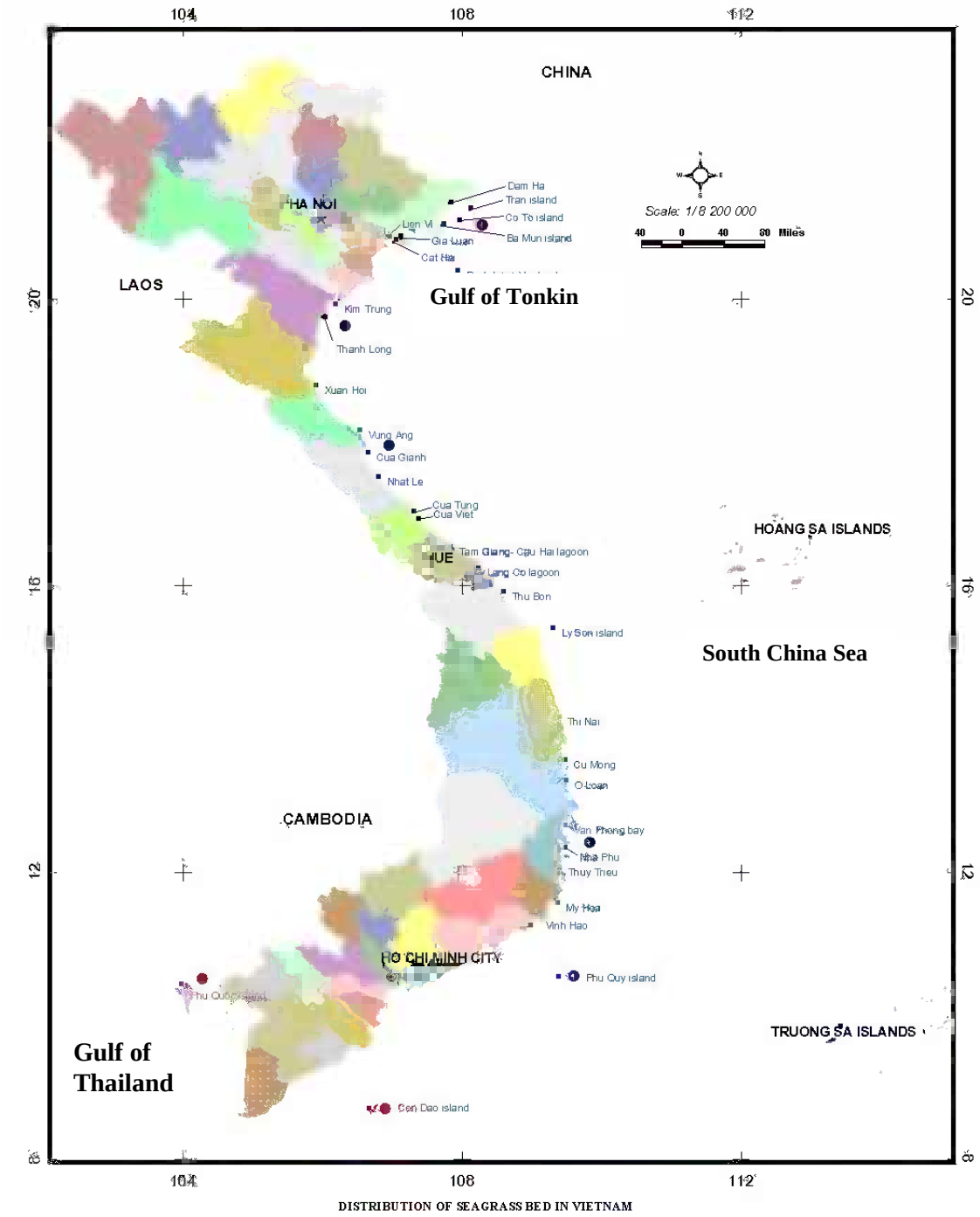

Figure 3: Seagrass distribution in Vietnam (Tien NV et al, 2004)

1. Assessment of ecosystems and linkage with poverty alleviation

Provisioning services

Food
In a typical seagrass bed, for instance Phu Quoc - the largest seagrass bed in Vietnam, supports as many as 91 fish species, and 106 species of zoobenthos. The live fish food trade based on harvesting from seagrass beds brings substantial income for the local people due to the occurrence of economically valuable species belonging to the families Serranidae, Lutjanidae, Nemipteridae and Siganidae (Tien N.V. et al, 2006).
+ Direct benefits: harvest of the marine species living on the seagrass beds. For examples, in Tam Giang Cau Hai lagoon, local fishers can get an income of about 461,870USD from a total of 100ha of seagrass recorded (Tien N.V. et al., 2004).

Raw materials
Seagrass by itself can serve as raw materials to manufacture consumer goods such as packaging materials, and carpets etc (Hemminga and Duarte, 2000). It also provides a good source of fertilizer that can be used in the agricultural sector.

+ Benefits from selling fertilizer (seagrass is a good source for fertilizer) in the agriculture sector. In two communes in Tam Giang – Cau Hai lagoon, people can collect 20,000USD each annually from selling the seagrass.

Genetic sources
The total number of species living in seagrass areas is often 2-8 times higher than in offshore water (N.H. Dai, 2002). The seagrass bed in Thuy Trieu lagoon (Khanh Hoa province) is an important nursery ground for juvenile tiger prawns and has contributed to Vietnam becoming one of the largest shrimp exporters in the world. The tiger prawns' seed productivity is dependent on the presence of near-shore seagrass nursery grounds (N.H. Dai, 2002). Seagrass also is the principal food resource of the dugong (*Dugong dugong*). The dugong, a herbivorous mammal is strictly marine, and is listed as vulnerable to extinction by the International Union for the Conservation of Nature. Seagrass is also a major food resource for the green turtle (*Chelonia midas*).

Biochemicals, natural medicines and pharmaceuticals
Some seagrass dwelling species such as seahorse fish (*Hippocampus spp*) have been used as ingredients for traditional medicines (N.V.Tien et al, 2006).

Regulating services

Climate regulation: Each square meter of seagrass can generate ten litres of dissolved oxygen that contributes to balancing O_2 and CO_2 in the water environment, and assists to mitigate the greenhouse effects due to efficient absorption of the CO_2 in the water (Tien NV et al., 2004).

Erosion control: Seagrass meadows also help dampen the effects of strong currents, providing protection to shoreline and prevent the scouring of bottom areas.

Storm protection: seagrass beds help to protect construction works, local people's life and fishing vessels from strong winds, waves and storms.

Water purification and waste treatment: Seagrass ecosystems are involved in absorption, filtering and deposition of wastes.

Cultural services

Educational values: Seagrass beds are the field sites for formal and informal education of local people and students. They are also serve as field studies for researchers, students and conservationistsl.

Social relations: seagrass beds provide the opportunities for creating employment and establishment of the local communities in the coastal areas. They are the basis for superstructural relationships among users such as fishers, resource managers and scientists.

Ecotourism: several large and beautiful seagrass beds near Phu Quoc island (Kien Giang province) and Thuy Trieu embayment (Khanh Hoa province) can be promoted for ecotourism and enhancing public awareness to encourage greater involvement in conservation activities.

Supporting services

Soil formation: seagrass can trap the sediments from rivers and seas that accelerate sediment deposition.

Nutrient cycling/habitat: Within seagrass communities, a single arc ($400m^2$) of seagrass can product over 25 tons of leaves per year (Tien NV et al., 2004) this vast biomass provides food, habitat, and nursery areas for myriad of adult and juvenile vertebrates and invertebrates. Seagrass epiphytes also contribute to food webs - either directly via organisms grazing on seagrasses, or indirectly following the deaths of epiphytes which then enter the food web as a detritus carbon source. Seagrass beds serve as a favourable breeding and hatching ground for numerous marine species, and are important nearshore fishing grounds.

Primary production: Seagrass species and phytoplankton provide abundant primary production for the marine food web.

Table 7: Ecological and economic valuation of seagrass beds in Vietnam

	Location	National CPI	National (base 2005)
Fish	Phu Quoc	115	106.15
	Cam Ranh	100	92.35
	Tam Giang – Cau Hai	100	92.35
Crustacea	Phu Quoc	115	106.15
Fertilizer	Tam Giang – Cau Hai	100	92.35
Mariculture	Cam Ranh	100	92.35
Tourism and recreation	Phu Quoc	108	100
	Tam Giang – Cau Hai	100	92.35
Carbon sequestration	Phu Quoc	100	92.35
	Cam Ranh	100	92.35
	Tam Giang – Cau Hai	100	92.35
Purification of seawater	Phu Quoc	100	92.35
	Cam Ranh	100	92.35
	Tam Giang – Cau Hai	100	92.35
Nursery area	Phu Quoc	100	92.35
	Cam Ranh	100	92.35
	Tam Giang – Cau Hai	100	92.35

Source: N.H.Ninh, 2006.

Economically, Vietnam's 8,940 ha of seagrass support both commercial fisheries and services value at over 20 million dollars per year (UNEP, 2007). Based on the seagrass goods value (table 7), UNEP (2007) has estimated that each hectare of seagrass in Vietnam has an economic value of approximately $ 582,36US per year. Adding the economic value of the seagrass services such as tourism, nursery function, this figure increases to 1,678.77 dollars per year. The economic value of seagrass communities in the UNEP (2007) was lower than estimation of Costanza et al (1987) due to lack of data and information for each seagrass bed.

2. Trend dynamics of ES (changes)

2.1. The change of Ecosystems and ES

There have been reports of large-scale seagrass decline at 17 locations in Vietnam, almost all of which were attributable to human-induced disturbance. Trends for recovery remain unknown (N.V.Tien et al, 2004). The prospective trends for the future suggest that the status of seagrass ecosystems may be improving in some developed countries, because legislation is being rapidly implemented to protect seagrass meadows. Regrettably, the bulk of the seagrass meadows in Vietnam are found on the coastline, which is experiencing the greatest rate of environmental degradation at present, and will likely continue in the future. Rapid population growth in coastal zones leads to intense pressure on nature resources; however, the impacts on seagrass meadows from human activities and total extent of these impacts are as yet unknown. Taking into account the recent trends and anticipated threats identified, it is clear that the most likely scenario is one of major loss of seagrass ecosystems, although quantitative projections cannot be issued. In the future, the loss and recovery of seagrass may also be associated with the loss and recovery of important associated fauna and flora.

Box 3. Facts and figures of seagrass ecosystem change

- ✓ **Total area of seagrass beds distributed along the coast of Vietnam is 16,000ha**
- ✓ **Significant reduction of seagrass beds in recent years with the averages rate of 80ha loss per year from 1997-2002 (Khanh Hoa province)**
- ✓ **Mass mortality of seagrass in Gia Luan (Cat Ba). These phenomena occur due to:**
  - **Changing environment condition**
  - **Construction activities on the seagrass beds**

2.2. Driven factors, impacts on Ecosystems/ES

Seagrass ecosystems are subject to a number of biotic and abiotic stresses such as storms, shipping and accidental oil spills, siltation due to soil erosion, over-fishing, aquaculture, tourism, and destructive fishing methods. These are presented in figure 4 (T.L.Huong, 2004; N.H.Dai, 2005).

Natural impacts

- *Tropical storm*: in Vietnam storms are considered as the abnormal weather condition occuring during the summer months. Strong winds and rainfall disturb the marine water to such an extent as to directly affect seagrass community structure. For example due to tropical storm Linda (in combination with anthropogenic threats) 20-30% of the seagrass beds have been lost in Con Dao island.
- *Turbidity and sedimentation*: construction activities occuring on land are the main causes of increased water turbidity in coastal waters. Before 1972, *Zostera japonica* was distributed at high density up to a depth of 7-8m at Hon Soi Co and Bo Hon (Hai Phong and Ha Long); however due to land transformation caused by wartime activity, turbidity and sedimentation destroyed these beds (Tien NV et al, 2004).
- *Freshwater runoff*: Seagrass species have optimal salinity concentration of 15-30‰. Abnormal amount of freshwater run-off from inland (during rainy season) causes reduction of the salinity in the sea water and environmental stress for seagrass beds such as *Zostera japonica, Halophila ovalis, H. beccarii*).

Anthropogenic impacts

- *Destructive fishing practices*: In Vietnam, fishers use many destructive fishing practices (trawl fishing, fencing net, and Cyanide chemical fishing.) cause destruction to seagrass beds. Other activities such as collecting gastropods and vertebrates on the tidal flat cause disturbance of seagrass beds as well.
- *Aquaculture ponds*: seagrass beds are destroyed for the construction of shrimp ponds. This phenomenon seems to be particularly common in Khanh Hoa province where *Enhalus acroides* has decreased 20-30% since 1998 (Nguyen Huu Dai, 2002). In Ha Long Bay, Bai Tu Long Bay

and Tam Giang Cau Hai, the total area of seagrass decreased 45-50% which is directly related to the construction of aquaculture ponds (Nguyen Van Tien et al, 2004).

- *Coastal construction*: coastal areas are intense areas of economic development such as port construction and operation, trade, and tourism. The digging of canals and construction of ports in Ha Long Bay and Cat Hai island causes disturbance the substrate that increases water turbidity, making unfavourable condition for the growth of seagrass.
- *Land based pollution:* From 1987 to present, there were 90 cases of oil spills occurred in the estuaries and coastal areas of Vietnam. These have serious consequences for seagrass beds ecosystemas oil pollutants cause mass mortality at the effected sites.
- *Agricultural land reform***:** seagrass beds are under the pressure of the agricultural land reform process through the transformation of thousands ha of seagrass beds to the agricultural sector (Quang Ninh province as one such example).
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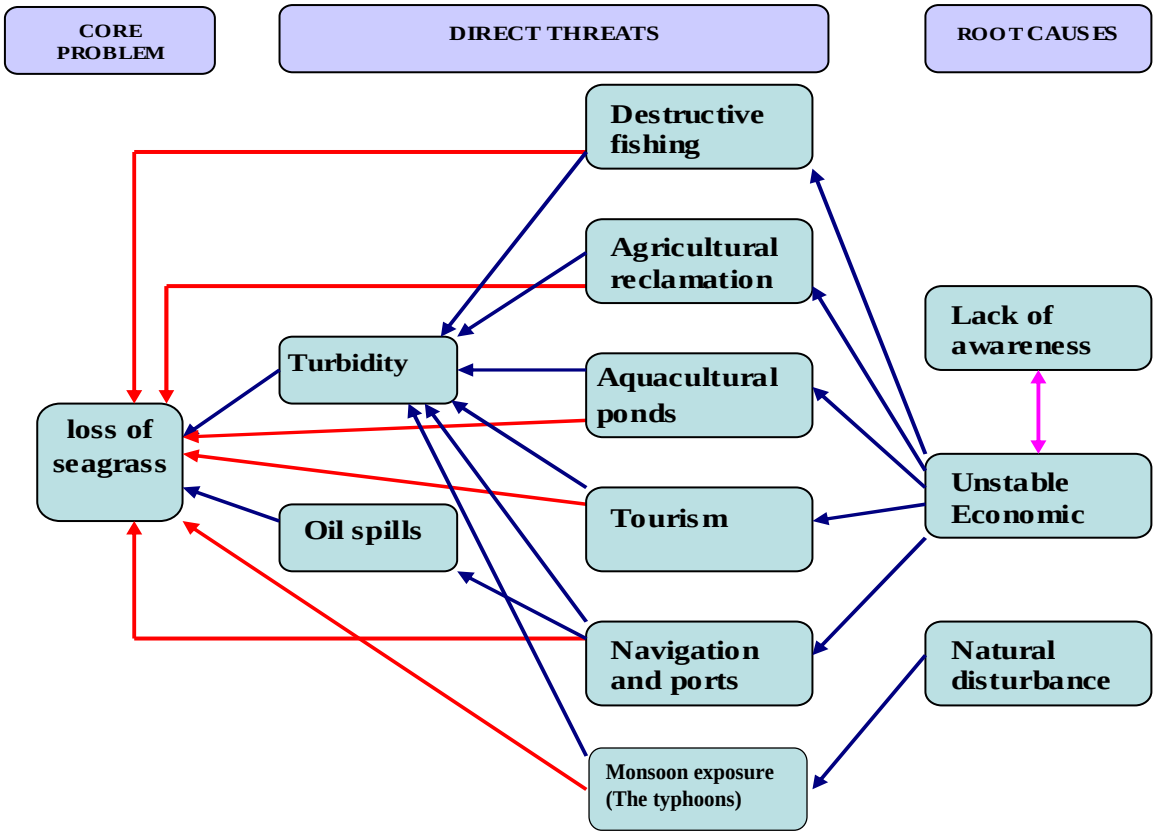


Figure 4: Causal chain analysis in seagrass beds in Vietnam

3. Links with poverty alleviation

3.1. Contribution to well being and the lives of the poor

Material minimum for a good life

The consequences of seagrass loss in Vietnam are well documented through observations of the changes in these ecosystems. A variety of reports from between 1995 and 2004 show a loss of 60% of Vietnam's seagrass area;some seagrass beds having totally disappeared (Tien et al, 2004) and large aquaculture operations being constructed along the coastline. Seagrass loss has been shown to result in significant loss of coastal biodiversity, leading to a modification of food webs and loss of harvestable resources. It is estimated that 85 marine species are listed at various levels as threat or endangerment and over 70 species have been included in the Vietnam Red Book (2007). There has been a declining trend in the marine resource production and fish sizes; for example from 1984 to 1994 benthic fish stocks decreased by 30%. In addition, the natural breeding stock of some species has significantly declined (Le

Quy An et al, 2004). According to fishermen, when seagrass beds in Bai Thom (Phu Quoc island) decreased, wild fisheries stock also reduced (Tien et al, 2006 observer).

In Vietnam, the depletion of seahorses, the most economically lucrative species found on the seagrass beds, has been well documented by Nguyen Van Quan (2003-2007) at Ham Ninh fishing village (Phu Quoc island). According to a fishery survey at Bai Bon and Rach Vem fishing villages, in 2003 a fishing boat was able to catch 10kg of seahorse per night in 1 km^2 of seagrass bed but in 2007 they could only harvest 800gr-1kg/ per night or even loss of profits because of exhausted resources. Numbers from the live fish food trade at Ham Ninh port, a busy center for seahorse buyers, also indicates reduction of in these species (Table 8).

Table 8: Status of the live seahorse trade in Ham Ninh port

Year	Species	Average size	Price VND/pair
2003	*Hippocampus comes* *H. hystrix* *H. kuda* *H. mohnikei* *Syngnathoides biaculeatus* *Trachyramphus bicoarctatus*	15cm	10.000
2006	*Hippocampus comes* *H. hystrix* *Syngnathoides biaculeatus* *Trachyramphus bicoarctatus*	10cm	18.0000
2007	*Hippocampus hystrix* *Syngnathoides biaculeatus* *Trachyramphus bicoarctatus*	10cm	47.000

Source: Nguyen Van Quan (2003-2007)

At Hon Roi fishing village (Phu Quoc island), the local people mostly depend on the capture fishery from seagrass beds due to lack of agricultural land. Unfortunately, only 30% of the fishery resource remains compared with that of 10 years ago. During the trade wind season (bad weather causing strong surf from April to June), they do not have enough food to eat because the fishers cannot go to the sea. Most of the expenses for everyday living is borrowed from other sources and is repaid during the next fishing season. Though the average monthly income reaches about 1,500,000 – 1,800,000 per fisher a month, they have to use 70-80% for buying food only 20-30% can be used for other necessities.

Good social relations

People living in communities where MPAs are located often receive benefits from alternative livelihood programs run by the government. They care more about the natural resources of their locale more than people not involved in such management arrangements (Angus McE, et al, 2008).

3.2. Issues of access to the benefits of the ES by poor people

The Vietnamese government is now trying to apply the co-management concept in terms of the sustainable utilization of ecosystem services (seagrass beds being one of these important ecosystems). In addition to the traditional agricultural sector, aquaculture development is being promoted. Nowadays, marine and brackish water aquaculture is developing rapidly in Khanh Hoa and Duyen Hai region (where seagrass beds are abundant). Total area for shrimp aquaculture has increased from 250,000 ha in 2000 to 478,000ha in 2001 and 530,000 ha in 2003 and today Vietnam probably has the largest total area for shrimp aquaculture in the world (Hambrey, 2001). Poor people can apply to get funding through the credit schemes at the women's association that are active at every village. Farmers can also get a land registration card for their own aquaculture area in the long time. Aquaculture can bring in high turnover, but maintaining such profit requires a certain level of skills, capital, technology, infrastructure and land which are often less accessible to the poor.

4. State of knowledge and gaps

There are few studies on the relationship between trend dynamics in the link between ecosystem services of seagrass bed ecosystems and poverty alleviation. Researchers have different focusses when studying coastal ecosystems. They neither integrate natural and social sciences perspectives nor expound on the relationship between the two. While other indirect factors come from ecosystem services such as mitigation of climate change through absorption of CO_2 in the seawater or shoreline protection values are overlooked.

5. Tradeoffs

5.1. User conflicts

5.1.1. Subtractibility of the ES benefits
Reduction of the ES will affect to benefits accruing to several different stakeholder groups. Such reductions may change stakeholder behaviour to rely more heavily on other ES if they can be captured in the same vicinity. A big social problem needs to deal with the resources sharing while the rich try to occupy the space to develop the industrial and tourist areas while the poor gets loss the benefits but can not change livelihoods due to a lack of the technical skills.

5.1.2. Impacts on ES of human activities
While local fishers want to encourage economic growth for poverty alleviation, they are often forced to exploit natural resources in such a manner that breaks down the ecological balance of the ecosystems they depend on (eg. reducing species diversity) which impairs proper ecosystem funcioning and works against sustainable economic growth.

5.1.3. Poor-Rich, Men-women, Ethnic/class conflicts
In rural areas, especially the offshore islands, men have more opportunity to receive formal education than women because the traditional culture of Vietnam still considers men as the grassroots of a family. A problem inherent in poverty alleviation is that rich people always have more opportunities to get richer. For example, rich people can invest more in services such as tourism and industrial works while poor people often do not have the required skills and capital investment

5.1.4. Regional-local
There may be conflicts between local and global interests. For example, collecting seagrass as fertilizer for the agriculture sector may directly affect the biomass of this natural resources.

5.2. Societal goals

5.2.1. Long-short term tradeoffs
For example harvesting seahorse and crabs on seagrass beds may bring more benefits for local fishers at the moment but also destroy habitat of valuable dwelling species.

5.2.2. Poverty alleviation vs economic growth, ecosystem and biodiversity conservation and cultural values.
Fostering economic growth can bring on coincidental social and cultural problems such as cultural transformation through the introduction of tourist activities based on seagrass beds. Tourism can also affect environmental health and biodiversity through the demands of food supply by the passengers. As an example, the decline of the seahorse fish stock at Phu Quoc related to the boom of tourists visiting Phu Quoc island in recent years.

5.2.3. Tradeoffs with other ES
Between societal goals: Economic growth versus social and cultural values versus environmental health and biodiversity.

Chapter 3: Lagoons

Lagoon systems of Vietnam are located mainly along the coastline of central Vietnam, from Thua Thien Hue to Ninh Thuan. The total area of these lagoons is about 447.7 km^2. The biggest lagoon is the Tam Giang-Cau Hai system which is more than 67 km in length with an area of approximate 216 km^2. The smallest is Nuoc Man Lagoon in Quang Ngai Province with an area of about 2.8 km^2. Currently, for a number of reasons, lagoons have not been properly managed and have been exploited irrationally leading to their degradation. Within the lagoon systems, there are four wetland groups, including non-vegetated wetlands, vegetated wetlands, wetlands with a water depth reaching six metres, and man-made wetlands.

1. Assessment of ecosystems and linkage with poverty alleviation

Provisioning services

Food and livelihoods
The lagoon system is a vital natural source (land and water as well) and is a favorable location for economic activities in many sectors including agriculture, fisheries, and forestry.

Raw materials
The flora and fauna inside the lagoon provides a source of raw materials for small scale business such as seagrass leaf used for making bags and fertilizer in agriculture sector

Genetic sources
The flora and fauna in the lagoon are composed of marine species, fresh water species and others adapted with variable environmental conditions. In Tam Giang Cau Hai alone, 839 aquatic species have been recorded so far, among which 40 species are valued for multiple uses (Ken LV and Quan NV, 2007).

Regulating services

Recharge and discharge of groundwater:
During the rainy season, when there is a surplus of surface water, lagoons act as storage tanks that allow water to gradually infiltrate into the groundwater system later during the dry season. This is a continuous process that supplies water for groundwater aquifers. In addition, a continuous process of recharge and discharge of groundwater from wetlands and aquifers also contributes to groundwater purification.

Trapping of sediment and toxic substances
Lagoon ecosystem can function as sinks trapping sediments, pollutants, toxic substances and other wastes, in order to purify water and reduce the possibility of marine water pollution. In central provinces, lagoon ecosystems trap sediments flowing from upstream to produce a high quality of soil for rice field development around lagoon.

Microclimate regulation
This function is particularly evident in lagoons having seagrass and mangroves such as Tam Giang – Cau Hai lagoon, where they contribute to balancing O2 and CO2 concentrations in the atmosphere, regulating microclimate (temperature, humidity, precipitation) and mitigating the greenhouse effect.

Flood control
Lagoons can function as water storage tanks, regulating rainfall and surface runoff, which slows the flow of flood water from upper streams and reduces floods in surrounding areas during storms or rainy the season.

Cultural services

Tourism
Several lagoons in the central provinces such as Tam Giang – Cau Hai, Lang Co, O Loan and Thuy Trieu now are opening for eco-tourism development. This creates many jobs for local peope through the construction and staffing of hotels and other related services.

Aesthetic, culture, education

Lagoons in central Vietnam are representative for typical coastal water bodies of the world both in term of size and primary characteristics. They are ideal case studies for public awareness and student education at various levels.

Supporting services

Nutrient retention:
Lagoon ecosystems can absorb nutrients, mainly nitrogen, phosphorus and microminerals, which are important for micro-organisms, fisheries and forestry development. This process also reduces eutrophication in coastal water bodies (harmful algae bloom), especially after natural hazards such as typhoon and heavy rain usually occuring in the rainy season.

Biomass production:
Biomass produced in lagoons provides food sources for aquatic organisms, livestock, wildlife and domestic animals. In addition, nutrients from rotten and decomposed organisms are transported by surface currents and provide food to downstream and coastal areas.

Maintenance of biodiversity:
Lagoons consist of many sub ecosystems such as mangroves, seagrass beds, and lagoonal estuaries. Their soft bottoms are favorable breeding, nursing and growing areas for a variety of wild fauna and flora. Many genetic resources, particularly those of rare and valuable species, are preserved in lagoonal wetlands (Box 4).

Box 4. Species diversity in the coastal lagoons of Vietnam

- **15 species of seagrass**
- **667 species of seaweeds**
- **94 species of mangroves**
- **~1,300 other species of fish and migratory birds**

Economic values of Vietnam's lagoons

Nguyen Huu Ninh, Mai Trong Nhuan et al., (2003) conducted a valuation of some typical coastal wetlands in Vietnam, including Tam Giang-Cau Hai Lagoon, Thi Nai Lagoon, southwest Ca Mau Tidal Flat, and the estuaries of Bach Dang, Ba Lat, Van Uc, Tien, and Day (Kim Son Tidal Flat). The results show that the Tam Giang – Cau Hai lagon has the TEV in rage of 31,125,200 VND (low value) to 35,208,500VND (high value) (Table 9). These estimated economic values may vary because other function of the ecosystem services such as regulating (flood control, mitigation of the climate change effect) services have not yet been determined.

Table 9: Total economic values of Tam Giang – Cau Hai lagoon

Direct value	Low value		High value	
	Estimated value in VND	Estimated value in USD*	Estimated value in VND	Estimated value in USD*
Timber	n/a	n/a	n/a	n/a
Fuelwood	n/a	n/a	n/a	n/a
Indirect value				
Aquaculture	16,850,000	1,101.31	18,450,000	1,205.88
Fishing	14,260,000	932.03	16,740,000	1,094.12
Marine product collection**	n/a	n/a	n/a	n/a
Tourism	15,200	0.99	18,500	1.21
Environmental value				
Stabilizing micro-climate, improving air quality, water quality, preventing the site from water surge, etc.	n/a	n/a	n/a	n/a
Total Economic Value(+) (per ha)	31,125,200	2,034.33	35,208,500	2,301.21
Estimated TEV		0.00		0.00

Source: Thanh, T.D et al., 1996, National Environmental Agency (NEA), 2001, cited in Nguyen Huu Ninh, Mai Trong Nhuan et al, 2003
Note: * unorganised fishing and marine product collection, conducted by household member occasionally or seasonally
** Currency exchange rate: September 2002, US$1= VND15,300
(+) TEV is estimated on the basis of total area of the identified wetland site
n/a: not available

2. Trend dynamics of ES (changes)

2.1. The change of Ecosystems and ES

Unlike other ecosystems that have been discussed in previous sections, lagoon ecosystems are characterized as complexity system in the coastal area where interactions between the land and the ocean always create unstable environmental condition. Consequently, seasonal changes in the lagoon ecosystems are pronounced. Abnormal weather condition (climate change related) and anthropogenic effects are the main causes for degradation of natural environment and reduction of ecosystem services.

2.2. Driven factors, impacts on Ecosystems/ES

From nature

Global climate change: heavy floods coinciding with the strong storms have occurred more frequently in recent years and these have a large impact on the natural condition of the lagoon. They lead to changes

in the salinity of the lagoon, infrastructure damage in the aquaculture sector, and lagoon inlet disruptions. In some cases, however, positive impacts have been observed post- flooding such as evidence of increasing in larvae stocks of crab and shrimp (Table 10) and a boost to the fishing yield in the Tam Giang – Cau Hai lagoon as good examples:

Table 10: Fishing yield (shrimp and crab) before and after opening of Tu Hien inlet (November 1999)

District	Production before flood (1999), (tons)		Production after flood (2000) (tons)	
	Shrimp	Crab	Shrimp	Crab
Phu Loc	1123	50	7448	933
Quang Dien	540	41	827	130
Phong Dien	165	9	419	74
Phu Vang	8819	938	10711	1826
Total	10647	1038	19405	2962

Source: Nguyen Van Tien et al. 2000

The potential closing of Tu Hien inlet in Tam Giang – Cau Hai lagoon has been determined to be a major threat. After the closing of Tu Hien inlet in December 1994, 1000ha of rice fields were flooded, 300 ha of shrimp ponds destroyed, and 300 fishing boats did not have a way to access the sea and had to use Thuan An inlet (40km far from Tu Hien) as an alternative route.

From human

Land based pollution: sources of pollution can be divided into three main categories: (1) organic pollution, (2) oil pollution, (3) residential wastes. Oil pollution is now acommon problem due to increasing number of small fishing vessels. Pesticide pollutants coming from agricultural activities also pose a threat to the living resources in the lagoon ecosystem (Thanh T.D. et al, 1996)

Unplanned aquaculture development and destructive fishing practices: The development of aquaculture ponds, enclosed net areas, and fencing causes the reduction of the water surface area, exchanging water masses and the depletion of dissolved oxygen in water. Destructive fishing methods such as electronic fishing and blast fishing still occur at the night time in most lagoons recent years causing to the reduction in fish yield over the years (Table 11).

Table 11: Fishing yield in the Tam Giang – Cau Hai lagoon

Years	1966	1973	1979	1985	1990	1991	1992	1993	1994	1995	1996	1997
Production (ton)	4042	4517	2575	2937	2100	2650	2250	2830	2500	2600	2927	2700

Source: Nguyen Van Quan and Lang Van Ken, 2007

Population growth: the quickly growing population (2.6%/year) causes stress to the living resources in lagoon ecosystems due to related overfishing (Thanh T.D et al., 1996).

Cutting down upstream forests, and the construction of reservoirs upstream causes nutritional reduction in lagoon system and impairs the balance of input – output energy in the water body (Thanh T.D et al, 1996). The lagoon food web can be disturbed through reduction of the primary productivity associated with these events.

3. Links with poverty alleviation

3.1 Contribution to well being and the lives of the poor

Material minimum for a good life

Lagoon ecosystems contribute to the needs and living condition of their residents; however they also pose challenges to the life of people settled there due to the dynamic environmental conditions.

(1) Global climate change: more storms and floods have occurred in recent years (possibly connected to climate change) which have damaged the infrastructure and life of the people living around lagoon. Data from Tam Giang – Cau Hai lagoon (Table 12) highlights the devastastion that storms can bring to these areas:

Table 12: Typhoons and the human impacts from 1980 to 2007 in Tam Giang Lagoon

Year	Human deaths and injuries
1980	173 killed
1983	252 killed, 115 injured
1985	604 killed, 234 injured, 98 missing
1989	53 killed
1992	7 killed
1998	31 killed
1999	373 killed
2007	22 killed, 35 injured

Source: Hue Department of Statistics

(2) Other natural hazards: The opening and closing of inlets in the lagoon system affect the natural dynamics inside the lagoon that cause diversification in terms of aquatic resources. In Tam Giang – Cau Hai lagoon, the closing of the Tu Hien inlet in 1994 meant that fishermen had to access the sea via the alternative Thuan An inlet (40km far from Tu Hien) which was costly and had an impact on their material well-being (Thanh, T.D et al., 1996)

Good social relations:

According to Ton That Phap (2003), the local fishery communities in lagoon ecosystem can be divided in two groups: land-dwellers and sampans-dwellers. The 1st group consists of 3 sub groups: sea fishing people, farming people and lagoon fishing people. The 2nd group is fishers who live on their sampan on the lagoon and who have no land to build a house. They live together forming small communities based on their family and occupation relations. Their communities are called "van". A leader of the "van" and a representative board are elected to manage community activities such as organizing rituals or ceremonies protecting rights for "van" people

The poor households earn a living by mobile gear fishing (gill net, push net, hook) which is called “minor fishing” as it requires small capital and investment. Comunities with this type of livelihood are called "minor fishers community" (van tieu nghe). On the other hand the fishers with fixed gears such as fish corral bottom nets form major fishing communities (van dai nghe) with larger capital and investment. Both major and minor fishing communities live together on the water near the lagoon banks. All these people are called sampan people. Not accepted by villagers on the main land as village members sampan people had to gather on boats. Due to their origins sampan people were consider as people with "no land to live on and no land for graves". The Vietnamese language has some contemptuous words (Nooc ke

nooc) used to refer to them. This distinction between land and water people has existed for many centuries and still exists now.

3.2. Issues of access to the benefits of the ES by poor people

Lagoon as Common property with different access rights

Customary folk tradition, supported by continuing practices, maintains that surface water bodies such as the lagoon are open access areas. However, management bodies and local people have divergent views about access rights to the biological resources of the lagoon. Persistent confusion is due partly to the nature of the mobile and biologically dynamic resources, but a contributing factor has been the historical context, which saw all kinds of traditional access rights subsumed in the period of state collectivization. Collectivization of agricultural land use rights was relatively clear, but rights to the lagoon resources were also collectivized to some extent. Since the economic reforms in Vietnam in the late 1980's, even this limited collectivization has weakened, leaving a somewhat confused and contradictory access regime to the heavily-used resources of the lagoon. Awareness of these problems is only slowly growing.

Under present land use and tenure policies in Vietnam, only primary agricultural land is allocated to individual farming households for long term use via transferable leasehold titles referred to as long term land use rights. In practice, not all agricultural land is transferred to households. Degraded, abandoned, or shared-use lands remain legally under the jurisdiction of the government. Similarly, the lagoon water areas are not formally allocated by title, and can be argued to be public property under the management of the state.

3.3. Options for interventions (can the access by poor people be improved)

In the lagoons of Tam Giang, Thua Thien Hue province it is reported that local farmers and fishers have improved access to coastal resources through the support of the local government (namely provincial policies on land and lagoon allocation) and have been able to establish local fisher groups (such as aquaculture organizations) that can collectivize the process of economic development (Veronila J. Breski and Gary E.Newkirk, 2002). A co-management mechanism is used to plan and manage the lagoon resources where the local government's role is required to support the enforcement of the regulations and management policies in the lagoons.

4. State of knowledge and gaps

There are no direct studies done at the loca level which highlights the linkages between the reduction of ES (eg.typhoons – floods) and the poverty conditions of fisher communities in the coastal lagoons of Vietnam.

5. Tradeoffs

According to Truong Van Tuyen et al, 1998 several tradeoffs among the ES and users in lagoon ecosystem occur as following:

Gender - There is a big inequality in gender relations between men and women in lagoon areas. For example in Quang Phuoc commune (Tam Giang Cau Hai lagoon), women work 14 hours a day while men work 9 hours a day. In the farming communities, men also work 9 hours a day and women work 13 hours. Furthermore, men usually participate more in community work (75%) including attending village meetings, workshops, and wedding parties. This role helps men in terms of social relationships, knowledge, and information. The fact that women spend so much time on household chores prevents them from participating in development activities for themselves and their communities.

Although discrimination is often intangible, because of gender stereotypes, women have limited access to and control over resources such as education, healthcare, information, technology, credit and land. The lack of family planning/ birth control and cultural beliefs means that if after two children there is no son the family usually keeps trying.

Mobile fishers vs. Fixed fishers - In general, water area and aquatic species are considered open access for all fishers. However, fixed gear fishers have rights (though limited) to their own fishing grounds while mobile gear fishers have very limited rights to fish (limited by time and specific location) in those grounds. Unequal shares to fishing grounds lead to unequal benefits among fishing groups which results in conflicts. Other conflicts occur among fishers because of the use of illegal gears (eg. electric fishing) by certain groups and also because of gear efficiency (eg. fixed gear fishers claim that mobile fishers use small mesh sizes that over exploit resources).

Farming groups vs. fishing groups - Different groups living around the lagoon have access to different natural resources. The farmers want to fish but in return, refuse to share their land with the fishers who want to practice farming. The fishers want to have land holding and, as well, compete to gain a higher share of fishing grounds and water area for aquaculture. This problem is also related to high population increases; the land and lagoon area remain constant while the number of farmers and fishers exploiting these areas is constantly increasing. In other words, high unemployment results in increasing competition for resources.

Settled groups vs. Sampan groups - For a long time, there have been people living on boats in the lagoon and in the rivers. Although they are not part of a racial minority, their lifestyle, after many generations, have given them unique cultural characteristics. With their boats, they are mobile and earn their living by fishing thus the decrease in natural fish stocks have impacted their livelihoods. In 1985, an unexpected typhoon killed many sampan people living on the lagoon. Unrelenting poverty and threats from natural disasters are forcing them to abandon their lifestyle and attempt to settle on land. The government encourages this resettlement but does not provide appropriate land nor assistance because farmers and fishers that are already settled do not want to lose land nor increase their crowded population. Attempts at settlement have resulted in conflicts between sampan people and existing communities.

These conflicts among different user groups are somewhat different from conflicts among competing strategies in management of the lagoon resources, as user groups and management strategies overlap. Researchers identified some of these distinctions and made efforts to describe strategic conflicts for the benefit of local officials and resource users who might not have recognized or perceived conflicts in this way before. Strategic conflicts consist of.

Aquaculture vs. Fishery- Privatization of water area for aquaculture (ponds and net enclosures) has reduced the public area available for fishing. This has caused some serious conflicts including sabatoge of aquaculture structures by fishers.

Agriculture vs. Aquaculture- In Phu Tan commune (Tam Giang – Cau Hai lagoon), the conversion of marginal rice lands into aquaculture and the construction of ponds required the destruction of a dike which protected agricultural lands from saline intrusions. Though adjacent rice fields were thought to be protected by an embankment formed by the main road, saline intrusion did affectthem.

Agriculture vs. Fishery - In the northern part of the lagoon, salinity fluctuations have decreased. This is correlated to a decrease in the diversity of aquatic species. Physical modification of the lagoon through the construction of a dyke to improve agriculture may have affected circulation of seawater and nutrients. The villagers claim that before Cua Lat dike was rebuilt to prevent salt water from leeching into the nearby rice fields, salinity in the lagoon area was higher, fish catches were higher and some exportable species such as tiger prawn were still available. At present these species are no longer caught.

Chapter 4: Mangrove forests and coastal Tidal flats

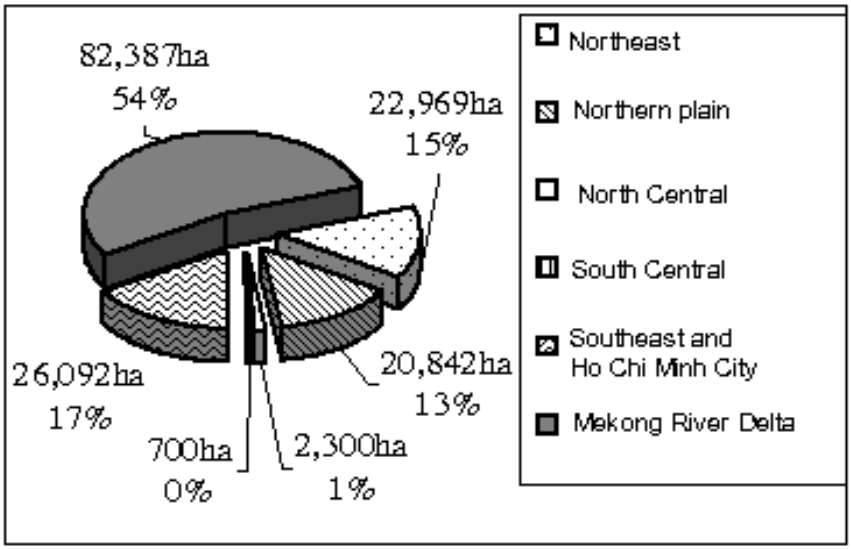
In Vietnam, the coastal tidal flat ecosystem supports and nutures a wide array of coastal forests species, including many of the mangroves. Mangroves develop well in the areas of river estuaries and coastal lands in the North and the South (see Figure 4). Mangrove ecosystems include not only mangroves but also organisms living in the water and sandy/mudflats within these areas.
Among the major costal tide flats that support mangrove systems in Vietnam are:

a) Estuarine areas and coastal tidal flats of the Red River System (from Do Son to Lach Truong): The total surface of the tidal flat is 452.000 ha, among this the high tidal flats having the mangrove forest are of 188.000 ha (occupying 41.6%), the low tidal flats of 264.000 ha (occupying 58,4%) (Nguyen Chu Hoi eds., 1996).
b) Estuarine areas and coastal tidal flats of the Mekong System: The surface of high tidal flats having the mangrove forest occupy about 70 - 80%, and the rest consists of low tidal flats. The important feature of the Mekong estuarine area consists of the natural development without the dependence to the sea dike separating the rice-field ecosystem with the sea ecosystem.
c) Estuarine areas and coastal tidal flats of the Central Vietnam: The Ma River and Ca River estuarine areas have rather high tidal amplitude of 2.8-3.6 m, a not uniform daily tidal regime forming a rather large estuarine tidal flat. The surface of the estuarine tidal flat of the Ma River is about 2,000-3,000 ha, that of the Ca River is about 1,000-2,000 ha.

In addition to this, there are the funnel-shaped estuarine ecosystems - these are estuaries areas that tend to invade into the mainland. In Vietnam, the major funnel-shaped estuarine areas that supports mangroves are found in:

a) Eastern of Northern part funnel-shaped estuarine area and coastal tidal flats; including small estuarine and tidal zones extending from Mong Cai to Yen Lap of the East Bac Bo coast as in Cua Luc, Tien Yen, Ha Coi and Ka Long: The total surface of the high tidal flats occupies 40,000 ha, where the mangrove forest is well developed, belonging to the best in the North coast. The total surface of the low tidal flats is about 20,000 ha.
b) Funnel-shaped estuarine area and coastal tidal flats of the Bach Dang River: This area lies in the north of the Red River deltaic estuarine area, extending from Do Son town-let to Yen Lap and invading to Pha Lai - Ben Trieu. The subterranean shore zone extending from the basic shoreline to the depth of 10 m runs from the outside of the Hon Dau Island to the southwest of the Cat Ba Island. The river system emptying into the estuarine area includes the Thai Binh river system with the two Lach Tray and Cua Cam estuaries. The total surface of the estuarine area approximates 95,000 ha including the high tidal flat with the mangrove forest, low tidal flat without the mangrove forest and the underground tidal zone.
c) Funnel-shaped estuarine area and coastal tidal flats of the Dong Nai River (East Nam Bo region): This is the largest funnel-shaped estuarine area of the country, having the total surface of the estuarine area of about 120,000 ha, among this the high tidal flat with mangrove forest occupies 75,000 ha, the low tidal flat without mangrove forest – 10,000 ha and the rest of 35,000 ha consists of the water surface of a dense tidal channel system.

Figure 5: Mangrove distribution in regions of Vietnam



Source: Sam eds., 2005

1. Assessment of ecosystems and linkage with poverty alleviation

Provisioning Services

Food - Mangrove ecosystems provide a number of foods, by way of marine products. They also provide good feed for livestock

Fuel materials - Branches, roots and mangrove stands are valuable sources of firewood and charcoal material.

Construction materials - The mangroves have been exploited for construction (e.g, leaf stem as materials for roof and wall; timber for poles).

Genetic resources - The diversity of genes of mangroves and other species in mangrove/mudflats are valuable in local, national and global level (for example migratory water birds).

Biochemicals, natural medicines, and pharmaceuticals - There are some mangrove species that can be used for medicine production, tannin extraction, and sugar making.

Green Fertilizers -The leaves of some mangrove species are used to make green fertilizers in agriculture production.

Regulating Services

Climate regulation- Mangroves contribute to balancing O_2 and CO_2 in the atmosphere, and regulating the local climate (temperature, humidity, rainfall) and mitigation of the greenhouse effects.

Erosion control - Mangrove vegetation is important to erosion control. Due to the adaptive features of the root system, mangroves can stand firmly in coastal estuarine areas, and anchor sediment from tide and wave actions. Mangrove vegetation has an interwined system of roots. Every year, pioneer species gradually invade the new tidalflat areas, forming a protective covering layer.

Storm protection and wave reduction - Mangrove plants help protect see dikes, construction works, crops, settlements, and fishing gears from strong winds, waves and storms.

Water purification and waste treatment - Mangrove ecosystems are involved in the absorption filtering and deposition of wastes.

Pollination - An increase in mangrove area (such as *Kandelia obovata and Aegiceras corniculatum*) increases the population of bee pollinators.

Cultural Services

Educational values- Mangrove ecosystems are places for formal and informal education for local people, and students. Mangroves are study sites for researchers and students as well.

Social relations - Mangrove rehabilitation has created employment and formal social relationships among local people in coastal areas (the relations between mangrove planters, forest guards and resource exploiters). These relations need to be nurtured for the sustainability of the mangroves.

Ecotourism. - Mangrove forests provide high potential for sightseeing and eco-tourism. Bird sanctuaries and special use mangrove forests could be good eco-tourism sites (together with historical vestiges, religious work, and traditional festivals).
Recreation expansion.- Clean air and a beautiful landscape would provide a good place for recreation.

Supporting Services
Soil formation - Mangroves acts as a shield trapping sediments from rivers and seas, and accelerating sediment deposition.
Nutrient cycling/habitat - Mangroves are a shelter (a part or the whole life cycle) for many valuable organisms. The mangroves are characterized by the high biodiversity and are the natural habitat of many juvenile aquatic species and birds.
Primary production - Some mangrove plant species, zooplankton etc. create abundant primary production.

1.2 Relevance to poverty alleviation

Poverty in coastal areas has been studied in almost all coastal districts covered by mangroves. The data on poverty is the result of investigation on poverty carried out by the local authorities or researchers. Although, the poverty rates in mangrove dominated areas are not as high as in mountain areas they are nonetheless remarkable (Center for International Economics, Canberra and Sydney, 2002). Drivers for coastal poverty, according to Luttrell C. et al, 2004, include:

- Coastal regions of Vietnam have the highest rural population densities, many coastal districts are now undergoing rapid population change.
- Environment degradation which has resulted in the reduction of fish stocks and poor quality of land for agriculture.
- Changing labour markets and migration patterns are resulting both in new opportunities and the loss of traditional opportunities, requiring a diversification of skills.
- Limited access to new technologies, skills, markets, capital and networks which make it more difficult to adapt to rapid change and easier to lose opportunities.
- Prone to natural disaster such as flooding and typhoons. In these events, it's likely that the poorest suffer the most.
- In the view of livelihoods, coastal poverty is rooted in the diversity and mobility of livelihoods, fishery traditions and the associated low reliance on agriculture (which happens to be the highest prioritised sector for livelihood protection by the State).

Knowledge and studies on the links between ES of mangrove forests and poverty alleviation/human wellbeing in mangrove forest are still limited. Most of the available literature focuses are on the role of mangrove ecosystems in providing food and materials for poor people.

1.3 Ability to characterize trends

Vietnam's mangrove forests have been significantly degraded between 1943 and 1999, declining from 409,000ha to about 155,000ha (62 percent decline). The loss of mangroves occurred most significantly between the years 1960 to 1980 (Sam eds., 2005). Begining with the Can Gio mangrove forests in 1978, reforestation has been taking place in many provinces in the north and south of Vietnam since the 1990s.

According to the Vietnam Environment Monitor: Biodiversity (VEPA, 2005), the last comprehensive national inventory of mangroves was carried out in 1999. A range of site-specific data suggests that the combined controls and replanting programs in all regions appears to have slowed the decline of mangroves over the past few years.

2. Trend dynamics of ES (changes)

2.1. The change of Ecosystems and ES
Before the wars (1943) the total mangrove area in Vietnam was about 400,000 ha with primary and dense forests (Hong et al., 2007). The massive destruction of mangroves due to the wars together with human impacts drastically reduced the mangrove area. With recent and ongoing efforts to maintain and recover mangrove forests, Vietnam had some 156,608 ha of mangrove, including secondary and replanted

forests, as assessed in 2001 (Sam eds., 2005). For example, Can Gio Biosphere Reserve, located in the coastal district southeast of Ho Chi Minh City, has become one of the most extensive sites of rehabilitated mangroves in the world. It covers over 75,000 hectares and is dominated by mangroves, including both salt water and brackish water species. About 94 species of mangrove plants are found.

Mangrove ecosystems have shown a trend of increasing degradation during the period from the early 20th century to the 1990s, however, they appear to have stabilized in the last ten years. In some provinces, mangrove cover has even increased such as Nam Dinh Province in the north. Can Gio mangrove forests in the south is typical example of very good replanted and protected forests in Vietnam.

The destruction of natural and planted mangroves along the coast has decreased the quantity and quality of marine life which often live their whole or part of their life cycle in mangrove forests (Hong et al., 2007). Indiscriminate forest destruction has greatly reduced the stocks of shrimp and crab because of critical habitat loss. The ability of mangroves to protect local people from disasters has also been limited as the mangrove areas are cleared. Thus, it can be seen that the associated ES of mangrove have been altered. Few aspects of ES change are discussed in published documents.

2.2. Driven/impact factors

It can be seen that aside from natural phenomena (such as climate change and natural disasters), human activities also impact ecosystem functioning and thus the linkages between ES and human well-being. In their turn, the ecosystem changes alter the service provided to humans. The direct and driven factors causing changes to mangrove ecosystems/ES in Vietnam are discussed as follows:

Population increase: The population in Vietnam has doubled over the past 60 years (over 80 million in 2008) and population density is more than 200 people per 1 km^2 - one of the highest population densities in the world. This has drastically reduced the amount of available agricultural land per person. Population growth has also placed a large burden on the natural resources in several other ways. They need to find extra cash income for the food demand and it led to the over-exploited natural resources (Dao et al., 2007, Hong et al., 1999).

Over and destructive exploitation: After the war, the demands for wood for construction, firewood, and charcoal, and increased activity by forestry interests has exhausted many mangrove resources. Aquatic organism in the mangrove ecosystems are also over exploited. Destructive fishing practices characterized by unsustainable techniques and short-term thinking are reducing the habitat and species diversity of mangrove ecosystems. Among these techniques, are the use of dynamite, poison, and electric fishing which cause severe degradation of aquatic resources (Hong, 1999; Dao, 2001, UNEP, 2007).

Conversion of mangrove areas to shrimp ponds: Due to lucrative nature of shrimp exporting and because the catch yield has decreased, shrimp farming has been encouraged by the government and many local authorities. This has indirectly caused the destruction of mangrove forests to make shrimp ponds. Since the 1980s, this has happened on a particularly large scale in Ca Mau, Minh Hai and a large of mangrove areas were destroyed (Hong, 1995). By the end of the 1980s, shrimp aquaculture has also expanded extensively in the central and northern region of Vietnam and also caused the reduction of mangrove forests.

Conversion of mangrove areas to agricultural and salt production: Many mangrove areas have been converted into agricultural land and salt fields. Oxidization, salt endosmosis and acidification in these areas often turn the soil into completely fallow land (Hong, 1999).

Impact from the urbanization and industrial production: The construction of towns, ports and factories has many negative effects on the environment through the introduction of domestic and industrial waste into the water column and boats that discharge oil and other toxic substances.

Impacts from the construction of dams and reservoirs on rivers: The construction of dams and reservoirs on rivers has destroyed the natural breeding grounds and migration routes fresh and salt water fish at river mouths. Fewer nutritive substances are transported to the river mouths, which has strongly affected the structure of flora and fauna communities, especially in the breeding season. Changes in river flow combined with the monsoon's effect have transported salty water deep into the mainland, resulting in intrusion and alterations to accretion processes (Hong, 1999).

Impacts of navigation: River transport activities result in the erosion of river banks due to the plying of large motor boats which has washed large sections of mangrove forests. River transport also causes pollution, via oil spills (Dao, 2001). The mangrove seedlings are also seriously affected by oil pollution (Mien et al., 1994).

Ineffective coastal management: There is a weak enforcement of the laws that protect mangrove forests. Furthermore, the coordination of management responsibilities among economic sectors and other stakeholders in the area are not well defined (Hue, 2004; Dao et al., 2007).

Increasing demand from the domestic and international market: Demand for shrimp, crab, and other marine-products has been increasing. Vietnam's main marine export products are shrimp and clam. As demand has increased, measures to boost supply have also been taken. As a consequence of such actions, pressure on natural marine resources and entire ecosystems has also been increasing (Dao et al., 2007).

Climate change: There are many environmental factors that affect these ecosystems as a whole, but climate change poses a large threat as it not only affects biodiversity directly but also has indirect impacts through impacts on environmental hydrology and edaphon. Frost caused by low temperature damages the mangroves in the north of Vietnam Inundation due to sea level rise is also a cause for concern (Hong et al., 2007).

3. Links with poverty alleviation

3.1. Contribution to well being and the lives of the poor

Providing materials for a good life
Mangroves and non-timber products from mangrove ecosystems have been exploited for centuries. They provide both food and structural materials for communities. Amongst the mangrove species, only a few species are of little direct economic value, the rest can be put in the following categories of utilization (Hong & San, 1993; Hong et al., 2007):

- 30 species giving timber, firewood and charcoal
- 14 species giving tannin
- 24 species providing materials for green fertilizer making and improving or maintaining soil
- 15 species providing herbal medicines
- 21 species providing honey for bee-raising
- 1 species providing sap for producing soft drinks, sugar and alcohol.

Timber
Of the species providing timber, usually surveys only account for the 5 - 6 species which give high productivity such as *Rhizophora, Avicennia, Bruguiera, Lumnitzera*. Among these species, the uses vary from locality to locality with different ecological conditions and the trees' size. If the forests are well managed and business is carried out properly, mangroves can provide a significant flow of timber. The mangrove timbers can be used in various ways; most is used as poles, planks or to make tools in the communities. They are also used in many countries as railway sleepers, as supporting poles in furnaces and in making paper (Hong eds., 1998).

Charcoal
About 1 kg of *Rhizophora* charcoal produces 6,675 Kcal and the same amount of *Bruguiera* charcoal produces 6,375 Kcal. These are the preferred species for this use. *Rhizophora* charcoal can be used in the metal lurgical industry. Charcoal from *Lumnitzera racemosa* was used to run steam ships in the Second World War. Charcoal making used to occur on a widerscale than it does today because of a lack of materials (Hong et al, 1993, Nam, 1993; Dao, 2001).

Firewood
Trees in mangrove forests also supply an important source of firewood. Many species give good-quality firewood with little smoke and high energy. In the past, the coastal dwellers in all mangrove areas of used firewood from mangroves put this practice is decreasing. In some areas, firewood can be exploited more sustainably by thinning rather than clear cutting (Dao, 2001).

Tannin
Another product from mangroves is tannin; some species can provide higher concentrations than others. The percentage of tannin varies between 4.6 - 35.5% with different species with the quality of the tannin generally being quite good. Tannin is used for curing leather, dying cloth and fishing nets, making glue, producing pharmaceutical products, and printing. The number of species producing tannin is high, but only 5 - 6 species give high yields and are commonlly exploited. The bark of *Rhizophora apiculata* 25 cm in diameter is 1 cm thick, and thick-barked *Ceriops* can provide 7,740.47 kg of bark/hectares and 3,956.91 kg of branch bark/hectares (Hong et al., 1993).

Roof materials
Nypa fruticans leaves have been used to thatch their roof and make house walls. it is also used to make other home utensils like brooms, water scoops, baskets and hats (Ba, 1996., Thoa, 1999; An et al, 2004).

Sugar making
The percentage of sugar in nipa sap is rather high, 13 - 17%. Research results of P.N. Hong and collaborators (1993) show that one hectare of *Nypa fruticans* in Thanh Phu, Ben Tre produces enough sap to make 8 - 10 tons of sugar or 720 - 730 little of wine.

Terrestrial animals
The terrestrial animals living in mangrove forests excrete a large amount of faces everyday, which is a source of nutrition for the forest trees and also food for various creatures such as small invertebrate animals, shrimp and fish in canals and rivulets (Hong et al., 1993). Terrestrial animals residing in mangroves used to provide a source of foods to villagers; however with forest destruction and the over-hunting and trapping of mangrove animals, populations have declined greatly and some species are in danger of extinction due to the loss of their habitat. This, combined with policies on protection of the terrestrial animals in mangrove areas has ensured that terrestrial animals are no longer consumed as a food source.

Wild fishery products and aquaculture
Mangrove ecosystems provide provisioning services including food from fishery resources. Because of high primary production and available nutrition (through humus, fallen leaves and fruits, humus-eating animals as prey), the composition of the fauna in the mangrove areas is very abundant and diverse. Survey results demonstrate that in the mangroves of Vietnam, 80 crustacean species, over 160 mollusk species and 250 fish species are found. According to Do Van Nhuong et al., (2004), the density and biomass of benthos in the mangroves are more diversified than those outside the mangroves. In the bare flat, the number of individuals and biomass decreases. Mangroves are also the nursery for valuable offshore fish species that are important stock for offshore fishing.

It is recognized that mangrove forests are a good place for the farming of shrimp, crabs, fish and other brackish/salty water species. Correlating catch per unit effort with mangrove cover data, de Graaf and Xuan (39) estimated that one ha of mangrove reforest supports a marine catch of about 450 kg yr–1 in the Mekong Delta (cited by Hong, 1993). They also found strong associations between total catch and mangrove area after adjustment for the capture effort. A study conducted by Dao et al. (2007) also shows high correlation between fishery production and mangroves areas.
It should be mentioned that the fishery products are extremely important source of foods and income for poor people. They mainly fish by hand or with simple gears.

Feed for livestock
Mangrove leaves are bitter but rich in protein and are good feed for livestock, especially *Avicennia* leaves. If rationally exploited and well processed, this can be an abundant, nutritious source of dry feed for both livestock and fish raised in cages or on rafts (Hong et al., 1999).

Green Fertilizers
The leaves of some mangrove species are used to make green fertilizers in agriculture production, especially *Avicennia* leaves which have high nutrients and are very good green fertilizer for certain kinds of planted species. When manured with green fertilizers made from mangrove leaves, cultivated plants are less prone to attacks by pests or fungi.

Honey

Of the agricultural products provided by mangroves, honey and are is considered of great economic value. Raising bees in mangrove forests is not complicated and does not harm the environment. On the contrary, the productivity of mangroves is increased thanks to the process of pollination. In mangrove forests, there are many species which bear flowers with honey such as *Avicennia, Excoecaria, Ceriops, Bruguiera, Rhizophora, Kandelia candel* and *Aegiceras* so bees can be raised on a small or medium scale (Tho, 2001).

Nutrition

The FAO Nutrition Country Profile (1999) report looks at health and nutrition criteria as an indication of poverty. The Poverty Working Group (PWG) (2000) mentions the nutritional value of aquatic resources, small shrimps and crabs. Although no discussion of the importance of aquatic resources is presented in the PWG report, it is strikingly apparent that in terms of weight, aquatic resources are the major source of animal protein. The fishery products provide a remarkable portion of nutrition for local people and therefore it also contributes to the reduction of the number of malnourished children in some extent. The results from survey in Giao Thuy District, Nan Dinh Province, 20-23 times per month, local people in mangrove areas have fishery products in their meal; among them 42-48% are from fishery catching in mudflat and mangrove areas. Not counting high-value species (such as tiger shrimps, crab babies, big crabs, etc), about 36% of catching fishery products are used for themselves (Tho et al., 2004).

Clean air

Mangroves can help regulate the local climate where they grow. Mangrove communities are a factor which cool the climate and decrease the temperature. There have been many typical examples of the loss of mangroves leading to changes in the micro-climate of the region. After the vegetation has been cleared, evaporation increases, resulting in the increase of water and soil salinity. They also produce plenty of oxygen during the photosynthetic process, making the air fresh. Mangroves may be regarded as “a green lung” of coastal cities, towns and residential areas (Hong, 1999; Dao, 2001).

Accumulation

Nguyen Thanh Ha et al., 2004 indicated that the averaged values of the below-ground C accumulation down to 100 cm depth vary from 71 to 82 ton C ha^{-1}. According to Le Xuan Tuan et al. 2005, CO_2 content of water in the forest (7.38mg/l) is lower than that in the area without forest (7.63 mg/l) in Giao Lac, Giao Thuy in 2004. Calculating the relationship between stand age (t) and total carbon accumulation(C) gave a result that: $C = 77.5e^{0.097t}$ (r^2=0.957). It would be induced that there is more than 70 ton/ha of potential C accumulation, which might result from the earlier mangrove coverage.

The accumulation is exponentially increasing at an annual rate of 9.7% due to the development of the newly planted mangroves. This evidently indicates the important role of mangrove vegetation in carbon accumulation. Thus, mangrove ecosystem makes contribution to balancing O_2 and CO_2 in the atmosphere, regulating the local climate (temperature and rainfall) and decreasing the green house effects (Hanh and Tuan, 2007).

Prevention from natural disasters

Mangrove forests significantly reduce coastal erosion and may provide protection from tropical cylones and tidal waves. Mangrove roots, especially where vegetative communities grow densely, help sediment to accumulate more rapidly. They both prevent the waves’ damaging activities and act as obstacles to promote sediment accumulation. These results indicate that the thickly grown mangrove leaves effectively dissipate huge wave energy which occurs during storms such as typhoons, and protect coastal areas. Referring to the past studies, our results suggest that the hydrodynamic knowledge in various mangrove conditions such as the vertical configuration of mangrove species, their vegetation conditions, water depth, incident wave condition and the relationships between these factors should be further accumulated and then quantitatively formulated in order to protect coastal areas from severe sea waves (Yoshihiro Mazda et al., 2006; Thai et al., 2007).

The coastal areas in the Central and Northern parts have been greatly affected by storms, tidal waves, and northeasterly monsoon winds. In order to safeguard the life of the community and prevent natural disasters embankment measures have been taken for thousands of years. Therefore, most of the localities have narrow strips of forests in front of the dikes. In some places, after mangroves were destroyed, the regional wind velocity soared suddenly, causing desertification due to moving sand which filled up canals and fields. The increased wind velocity also causes big waves to break dykes and dams

and erosion of the coastline. The loss of mangroves adversely affects the rainfall of the sub-region (Hong, 1999; Huyen, 2007).

Natural hazards, such as typhoons and storm surges, are not uncommon in coastal communities, particularly in the North-Central and Central Coastal macroregions. Each year, many typhoons have made landfall or otherwise affected Vietnam. All too often, such disasters threaten urban residential and commercial property and even destroy major elements of infrastructure, such as communication lines, roads, bridges, tunnels, and ships. Professional expertise and planning are critical in developing preventive measures, more durable building materials, as well as building codes to mitigate the damage caused by natural hazards. Thus, the protection role of mangrove should be increased to ensure the security for local people (Hong et al., 2007).

Freedom and choice

Observation of income shows that there is a variety of income sources for the people lived within mangrove areas. In the coastal areas, they are diverse occupations practiced by local people such as cultivation, aquaculture, fishing, salt making and other occupation. In the north, a study show that the share of cash income in a commune from mangroves varies from 35% to 50% of total income. In the south of Vietnam, the contribution from exploitation within mangrove areas to the income is larger, about 67% (Dao, 2001). Fisheries play a key role in income generation in coastal communities. Despite falling fish stocks and the low intensity of the activity, fisheries still plays an important role in incomes of many coastline communes (Luttrell et al., 2004). The research shows that in communes with less access to land, fisheries proved to be more vital and involve more households and individuals (Lebel et al., 2002).

Aquaculture has brought about the highest benefits, contributing a significant part to overall income (Hue, 2004). According to FAO, the development of coastal aquaculture has played an important role in national income increase, employment generation (service, processing and product consumption) as well as in improvement of the people's living standards for the cause of hunger elimination and poverty reduction (Turner et al., 1997; Pedersen et al., 1996).

A study in central coastal areas shows that, opportunities for significant productivity increases from fisheries are limited, but their role in providing stability of income to the poorest must be recognized (Luttrell et al., 2004). There are a large number of people who are involved in fishing as an irregular, seasonal or opportunistic manner as a component of a wider livelihood portfolio. For some fishing is a primary occupation and for others for a seasonal activity in vulnerable periods or when other income options are not available. The way in which many of the opportunities for growth, such as aquaculture and tourism, have the potential to result in significant inequality (and environmental damage) emphasizes the need for the careful targeting of funds for poverty alleviation *within* the commune (Luttrell et al., 2004).

There is a wide range of roles for aquatic resource in livelihood of poor people:

- As a primary occupation
  As a supplementary occupation in a diversified and/or integrated farming system
- As a seasonal activity in vulnerable periods – or when other options are not available
- A component of wider more diversified livelihood strategies with limited inputs and consequently lower risk i.e. a safety-net for weaknesses in other livelihood components
- An option for women (collect mollusca)

Mangrove forest serves as a shield to protect shrimp ponds against disaster and cost for pond maintenance is decreased due to less erosion of pond embankment. This creates more opportunities for local people to improve their income and to investment in production (Tho et al., 2004).

In coastal areas of Vietnam, tourism is growing rapidly. Mangrove areas have the potential to eco-tourism, which contribute to local livelihoods, especially in cases where the natural environment is the main attraction. Protected areas are a major existing and potential tourist attraction. There are a number of ongoing community-based tourism initiatives in Vietnam; for example, in Can Gio and Giao Thuy. This creates an opportunity for poor people to have extra cash income.

3.2. Issues of access to the benefits of the ES by poor people

The 'enclosure' of open-access resources and privatisation has occurred in all mangrove areas throughout the 1980s-1990s. Many of Vietnam's shrimp farms have been developed in mangrove forests and other wetland areas. Being in the tidal zone, these areas often operate as 'open-access resources' or lie at the discretion of local government for allocation to contract holders; many lack a long history of ownership, clear tenure rights or any official delineation of property rights (Luttrell, 2002). Enclosure of such open access areas due to shrimp farming, and decreases in quantity and quality of open access resources, has in some areas resulted in households increasingly being excluded from previously available livelihood sources.

In addition, subsequent failure of shrimp farming has led to the collapse of the household economies of many shrimp farmers and to a high level of debt. This is a trend seen more recently in other areas of Vietnam such as the north-central coastal area (Luttrell et al., 2004). In addition, study results indicated that that many of the members of the commune expressed anger at appropriation of resources by outsiders (Luttrell et al., 2004, Dao, 2001, Hue, 2004).

The 'enclosure' of open-access resources and the inability of many households to afford the conversion resulted in serious social upheaval and a shift in livelihood profiles. However, despite that context, open-access resources still make an increasingly important contribution to livelihood profiles of the poorest households (Luttrell et al., 2004).

3.3. Options for interventions

Considering mangrove ecosystems as forests, approaches with success in poverty reduction include (Sundelin et al., 2005):

- . More equitable benefit sharing to enable co-management of forest resources
- Greater control of forest resources to be passed to local communities
- More transparency in the forest land allocation process
- Effective implementation of regulations relating to benefit sharing
- incentives for forest protection and management with adequate enforcement measures
- Capacity building and research to identify how best forest areas could be managed for multiple benefits
- Resolving the institutional barriers for trade in forest products that adversely affect small-scale forest producers.

4. State of knowledge and gaps

Quantitative data to demonstrate the linkages are still not available.

5. Tradeoffs

Open access to natural resources and privatization of coastal area results in increasing gap between poor and rich people, woman and man and regenerate social conflicts between economic sectors, and at different scale such as regional-local long-term and short-term development. The issues of tradeoffs and appropriate measures to ensure sustainable development and poverty alleviation are discussed not adequately; therefore, it is necessary to conducts studies on poverty alleviation and tradeoffs for sustainable development in mangrove areas of Vietnam.

5.1. User conflicts

Subtractibility of the ES benefits
The overexploitation and destructive exploitation is difficult to control in most mangrove areas (Dao, 2001). It is nearly impossible to prevent people from fishing from commonly owned waters and each fisherman's use of the resource diminishes the amount left for others.

Impacts on ES of human activities

The increase of natural resource exploitation (such as mangroves, aquatic resources) within mangrove areas would cause the degradation of quality of the mangrove ecosystems, thus impact to other role of mangrove ecosystems such as protection role.

Poor-Rich, Men-women conflicts

The conflicts between the rich and the poor mainly related to the aquacultural practice. The woman and children are vulnerable group to that situation too. Primitively, the general population had open access to the coastal mud flat for catching. However, since the use of a few areas has been limited to people who illegally built rearing ponds of shrimps and clams, illegal possession of such land took away the living of many poor families. Many young girls and poor women became maids for richer families. Other poor individuals had to look after other people's pond and usually earned less than 200 thousands Vietnamese dong per month (Dao et al., 2007). They usually did not have any day of rest all week. Those who used to catch worms in the free-access mud flat were then hired to catch worms and clams with an income of less than 10 thousand Vietnamese dongs per day. As a result, contradiction begun and continued to rise between pond owners and the employers. Poor people had to go farther to the sea for catching, which proved to be more laborious and costly. Those who did not have money to hire a boat had to stay home and relied on agricultural production for a living. By doing this, they had enough rice for only 8 months per year though (Hue, 2004).

The rich earned more from the mangroves or the mangrove-related resources. The poor earned least of all. However, the poor depend more on the mangroves, as they don't have access to alternatives. The rich earned the most from the mangroves and the mudflats, because they had capital sources, labor, and management and entrepreneur skills. It is important to note that education was also considered among the factors differentiating households within the community. All of these factors will be analyzed in turn.

Aquacultural development makes the rich become richer and the poor become relatively poorer. When people with available funds participate in such marine-product rearing, the area utilized by low-income individuals to catch such products becomes limited. Therefore, their low-income becomes even lower. As a result, the boundary line between rich and poor becomes even wider. A study has shown that people seeking jobs in the urban areas subject to increase. One reason is because they do not have access to the coastal natural resources (Adger et. al 1997). In his study of the aquaculture and rural inequality in two northern coastal districts, Adger also argues that as incomes from non-agricultural production, including aquaculture, have become increasingly important inequality has risen.

The women take part in the activities generating the income; and most women participate in collecting, selling and delivering aqua-products. The number of working hours and income per month of women is high compared to that of men. In addition, they are also in charge of housework so they have many responsibilities and work hard. Apart for some women who make yeast, most of them do not have stable jobs (Thuy and Anh, 1998). Generally, women's workload is quite high and their incomes are usually lower than that of men in the same profession. Even families of women leaders are usually poorer than men leaders that are in the same situation. Men, especially male leaders, usually have greater access to natural resources, greater resource possession and better opportunity to get rich for themselves and their families (Hue, 2004). The limitation of "common resource" make difficulties for woman, lowered their income, nutrition. They have to go farther to collect, fish and this may cause the risks for them as well as they have to suffer more expenses on investment and labour force.

Regional-local and sectors

The marine and coastal zone has been under the jurisdiction of numerous management agencies for a long period of time. This has resulted in creating many overlaps in their tasks and functions, while other agencies are neglected in terms of their mandate. This matter was clarified at the end of 2003, when the decision of the National Government to delegate the management of marine protected areas to the Ministry of Fisheries, wetlands to the Ministry of Natural Resources and Environment, and forests to the Ministry of Agriculture and Rural Development. However, there is still lack of coordination related to the utilization and management of marine resources between the various management agencies, scientific research institutions and NGOs. The local community participation in the process of marine resource management remains very passive and the principle that "all are known , debated about, performed and monitored by the people" is often not well implemented". The ownership of coastal land and the surface of the water is yet to be clarified. A new Fisheries Law was passed in November 2003 and thus will take time to come into effect. Compliance with the laws relating to marine and coastal zone remains weak. The

various policies on marine environment management are still not well coordinated and systematic, and the scope of the various regulations appear vague and not bound up with the behaviours of objects to be regulated. The various conflicts of interests in the multiple-use of marine and coastal resources have not declined but rather continue to increase (Hue, 2004).

The mangrove forest land can be converted to the other type of land use by different sector of Government. By nature, any conversion/shift leads to conflicts in ecosystems' use targets of different sectors, Agriculture, Forestry and Aquaculture. Conflicts can arise about pond boundaries and water management in landscapes dominated by shrimp, but overall these are local and mostly among shrimp farmers themselves or among state enterprises, military operations, and local communities included poor people. To avoid those conflicts, it is necessary to have the practice of integrated coastal zone management to reconcile multiple demands of those sectors.

5.2. Societal goals

Mangrove protection has been implemented in many coastal provinces of Vietnam (all regions) to ensure the sustainable development. Some good examples of good mangrove conservation are indicated with typical case of Can Gio, Ho Chi Minh City. It shows that the income trend increases while the mangrove forest increased in term quality and quantity. But it needs to be more considered on the consequence of economic development, environmental pollution.

III. SUMMARY

The coastal and marine ecosystems in Vietnam provide a wide range of economic benefits (food, income, employment) and many social values (such as sight-seeing, entertainment, culture) to human well being and the poor through its important functions and services of regulating, provisioning, cultural and supporting. There is an increasing demand for ecosystem services due to a high population growth and economic development in the coastal areas. However, there is trend of decrease in ecosystem services, especially provisioning and regulating, due to the reduced ecosystem area, decreased productivity and less resilience, caused by anthropogenic and natural factors. This has directly negatively affected the lives of humans, especially the poor who have fewer opportunities to get access and benefits from ecosystem services.

The key issues identified by the national assessment about the linkages between ecosystems services and poverty are i) climate change effects on coastal communities; ii) nearshorenear shore over-exploitation and destructive exploitation iii) reduction and degradation of habitat, iv) low livelihood resilience and poor coastal zone management (see Annex 1 for summarised details).

As part of the research assessment results, it is identified that a number of critical challenges exist in relation to knowledge and capacity to address ecosystem services and poverty alleviation issues. While data and information about the ecosystems extent and trend are largely available, the understanding about services and values they provide for human being is very limited. In addition, there is an inadequacy of public knowledge about the poverty in the coastal zone. Therefore, the knowledge about the linkages between ecosystem services and poverty alleviation is also limited. Studies of the root cause and problems of poverty in the coastal areas and linkages of ecosystems and poverty alleviation are rare and are usually limited in scope. Research tends to be focused on ecosystem services or poverty alleviation separately and more often conducted at the local level (coastal province/district) rather than national level.

Coastal and marine ecosystem services are important for millions of people in Vietnam, especially for the small scale fishers and the poor who are highly dependant on the coastal resources for their livelihood. Their economic and social benefits and costs should be valuated properly, for awareness raising, actions and policy development to sustain the ecosystem services for the purpose of poverty alleviation and sustainable development.

Several trade-offs are considered in linking ecosystem services and poverty alleviation. It seems that the key practical trade-off is found in long-term economic development and ecosystem conservation versus the short-term goals. In addition, there are conflicts between different resources users (such as aquaculture vs. capture fisheries, tourism vs. conservation), between the poor and the rich, women and men.

To address ecosystem services and poverty alleviation in coastal areas in the long term, it is suggested relevant national policies and strategies are formulated and enacted. Several possible policy options could be:

i. *Co-management* is applied in fisheries management, with enforcement and support from both the government and community
ii. *Ecosystem based management approach* is introduced and applied widely to improve the rehabilitation and productivity of the ecosystems to sustain their services for the benefits of the human-being
iii. *Integrated coastal zone management* (ICZM) to enhance the planning of coastal zone and coastal resources uses, the cooperation of responsibilities between different stakeholders and the coordination of actions related to coastal areas
iv. *Private-public partnership* would be studied and examined as to better manage and sustain the resources to allocate the user rights and ownership of the resources

The following sections further summarie and analyse specific aspects and issues of ecosystem services and poverty alleviation linkages (see also table 3.2, below).

3.1 General national trends in supporting, regulating, provisioning and cultural ecosystem services

Vietnam currently has very diverse marine and coastal ecosystems - including more than 155,000 ha of mangrove forests, about 1300 km² of coral reef, nearly 500 km² of lagoons, about 16,000 ha of seagrass and many tidal flats and estuaries. These ecosystems have long provided important services to Vietnamese people, including supporting, regulating, provisioning and cultural services. Among a total population of approximately 85 million people, it is estimated that 20 million people are indirectly affected by marine and coastal services while 8 million poor people are directly dependant on such services.

The ecosystems are degrading in term of both quantity and quality over the last decades. Among 1300km² of coral reefs distributed along the coast of Vietnam only 1% are in good condition. Coral coverage has declined down to 30% in some areas since 1993-2004. General trend is towards wide scale coral reef degradation. Mangrove ecosystems have shown a trend of increasing degradation during the period from the early 20th century to the 1990s - however, they appear to have stabilized in the last ten years. Fish caught per ha per year from lagoon reduced by nearly half over the last decade. There is significant reduction of seagrass beds in recent years with the averages rate of 80ha loss per year from 1997-2002 (Khanh Hoa province).

***Trends of provisioning services*:**
The value for the annual production of goods and services of the coral reefs in Vietnam is estimated about USD 100 million. One square km of coral reef can provide a total of fish an equivalent to USD 10,000. One ha of mangrove reforest supports a marine catch of about 450 kg in the Mekong Delta. Vietnam seagrass support both commercial fisheries and services value at over USD 20 million per year. The total economic value of lagoon in Vietnam is estimated at more than USD 2000 per ha.

***Trends of regulating services*:**
The value of shoreline protection of the coral reefs can easily be seen in some marine area in the central provinces of Vietnam like Bai Tien and Hon Khoi, Khanh Hoa province. Mangrove forests significantly reduce coastal erosion and may provide protection from tropical cyclones and tidal waves. Mangrove roots, especially where vegetative communities grow densely, help sediment to accumulate more rapidly. Natural hazards, such as typhoons and storm surges, are not uncommon in coastal communities, particularly in the North-Central and Central Coastal macroregions. Thus, the protection role of mangrove should be increased to ensure the security for local people. Each square meter of sea-grass can generate ten liters of dissolved oxygen that contributes to balancing O^2 and CO^2 in the water environment, and assists to mitigate the greenhouse effects due to efficient absorption of the CO^2 in the water.

***Trends of supporting services*:**

A single square meter of seagrass can product over 25 tons of leaves per year. This vast biomass provides food, habitat, and nursery areas for myriad of adult and juvenile vertebrates and invertebrates. Seagrass epiphytes also contribute to food webs - either directly via organisms grazing on seagrass, or indirectly following the deaths of epiphytes which then enter the food web as a detritus carbon source. Seagrass beds serve as a favourable breeding and hatching ground for numerous marine species, and are important nearshore fishing grounds. Several offshore islands such as Hoang Sa and Truong Sa archipelago were created by the build up of dead coral skeleton. Many beautiful swimming beaches found in Ha Long and Cat Ba are related to the marine depositional regimes associated with the coral reef production.

***Trends of cultural services*:**
Coral reefs play a central role in Vietnam's marine tourism industry. The major recreation activities on reefs are snorkeling and scuba diving. Nha Trang City, for example, is one of the first marine tourism centers in Vietnam, showcasing its very diverse and abundant coral reefs surrounding the nearby islands. The number of visitors to Nha Trang is increasing (30,000 people in 1995 and 400,000 people in 2003). About ten percent of these visitors participated in diving and snorkeling on the reefs of Hon Mun MPA. These services brought a benefit about US$400,000 and accounted for approximately 2% of the total revenue from the tourist sector in Khanh Hoa province. Mangrove areas has the potential to eco-tourism, which contribute to local livelihoods, especially in cases where the natural environment is the main attraction. Protected areas are a major existing and potential tourist attraction. There are a number of ongoing community-based tourism initiatives in Vietnam like Can Gio and Giao Thuy.

Key factors that lead to changing trends in ES

Population increase
The population in Vietnam has doubled over the past 60 years (approximately 85 million in 2008). The population density of Vietnam is more than 200 people per 1 km². Vietnam has become one of the countries that have the highest population density in the world. This has drastically reduced the rate of available agricultural land per person. Population increase has placed a large burden on the natural resources in a few ways. The need to find extra cash income for the food demand and it led to the over-exploited natural resources

Over and destructive exploitation
After the war, the demands for building timber, firewood and charcoal, and the increasing exploitation by forestry agencies lead to resources becoming exhausted. Overfishing caused break down of the coral community structures (fishing down marine food web phenomenon). Destructive fishing practices - bad habits and short-term thinking are reducing diversity in habitats and species of mangrove, destroying the coral structure and causing mass mortality of the coral colonies.

Unplanned Aquaculture
Due to the big benefits from shrimp exports and because the fish catch yield has decreased, shrimp farming has been encouraged by the government and many local authorities. Therefore, both local people and state bodies have felled lush mangrove forests to make natural extensive shrimp ponds over all coastal mangrove areas of Vietnam. Since 1980s, this happened on a large scale in Ca Mau, Minh Hai, and a large number of mangrove areas were destroyed. In the end of 1980s, shrimp practice has developed strongly in the central and northern region of Vietnam and also cause the reduction of mangrove forests.

Impact of the urbanization and industrial production
The construction of towns, ports and factories have resulted in the increase of has many other bad effects on the environment as a result of discardingsolid domestic and industrial waste, which more than often is disposed into the coastal water.

Ineffective coastal management
The management of the coastal areas shows the weakness of law enforcement and the conflicts in exploitation of the natural resources. The coordination and co-management among the economic sectors/stakeholder areas are not close enough (Hue, 2004; Dao et al., 2007).

Increasing demand from the domestic and international market

Ever since shrimps, crabs, and other marine animal products became valuable, the consumption markets have also extended. As of today, marine-products are consumed throughout cities of Vietnam and other countries. The main export product is shrimp and clam. As the markets become more and more extensive, the demand for fishery production has increase, putting additional pressure on the natural marine resources/

Climate change effect
There are many environmental factors that affect these ecosystems as a whole, but climate change plays an important role as it not only influences the biodiversity directly but also has indirect impacts through factors such as the environmental hydrology and edaphon. Frost caused by low temperature damages the mangroves in the north of Vietnam. Inundation is one of the effects generated by sea level rise.

Poverty
This is one of the fctor that leads the poor to depend heavily on their ecosystems. Poverty has been studied at the district level of most coastal areas where the main ecosystems services are provided. In general, the poverty rate in coastal regions is lower than that in Vietnam's mountainous interior. However, in terms of density, the two deltas (Red river and Mekong river) and the Central Coast are the regions with highest absolute numbers of poor. Poor people in our analysis are typified as artisanal fishermen, often have small landholdings or are landless, and with very limited financial capital. Their livelihoods are strongly dependent on access to "common resources". Over the last two decades, the 'enclosure of the commons' and the privatization open-access resources have excluded many poor artisanal fishermen from their own livelihoods. Low resilience of livelihoods has exacerbated the situation of the poor people. The Vietnamese government is now trying to apply the co-management concept in terms of the sustainable utilization of ecosystem services. In addition to the traditional agricultural sector, aquaculture development is being promoted. For example, marine and brackish water aquaculture is developing rapidly in Khanh Hoa and coastal region. Total area for shrimp aquaculture has increased from 250,000 ha in 2000 to 478,000ha in 2001 and 530,000 ha in 2003. Today Vietnam probably has the largest total area for shrimp aquaculture in the world.

Poor people can apply to get funding through the credit schemes at the women's association that are active in every village. Farmers can also get a land registration card for their own aquaculture area in the long term. However, the long-term positive and negative impacts of current aquaculture practices are not fully assessed yet and further promotion of aquaculture should be carefully thought out. Environmentally, expansion of aquaculture ponds and sea water channels creates groundwater salination. Waste water from those ponds which is not treated is a source of pollution for the surrounding sea water. In truth, aquaculture can bring in high turnover, but maintaining such profit requires a certain level of skills, capital, technology, infrastructure and land which are often less accessible to the poor.

3.2 Key national trade-offs

The most critical national trade-off appears to be short term interests driving policies towards the exploitation of provisioning services rather than long term interests that might best be protected by conserving or enhancing regulating and supporting services. Cutting of mangrove forest for shrimp aquaculture or using coral reef for decoration or construction materials are typical examples of this conflict.

Conflicts also occur in the competing use of coastal resources by various user groups, such as small scale fisheries vs. aquaculture. Untreated waste from aquaculture ponds creates pollution in surrounding waters. Industrial vs. artisanal fisheries contributed by case of oil spills and environmental pollutions is severe in many areas. Examples of such conflicts can be taken from Halong bay in the north or Van Phong Bay in the central of Vietnam. Other conflicts regarding the provisioning of benefits from ecosystem services are fuelled by the increasing gap between the rich and the poor.

Aquaculture development makes the rich become richer and the poor become relatively poorer. When people with available funds participate in such marine-product rearing, the area utilized by low-income individuals to catch such products becomes limited. Therefore, their low-income becomes even lower. As a result, the boundary line between rich and poor becomes even wider.

There is also a gender issue in some cases in the coastal areas between women and men in access to the ecosystem services. In the traditional fishing communities, women have more working hours than

men, and they have less opportunities to training, education activities because of spending more time on reproductive work such as taking care of the children and thus this has limited their opportunities for income generation and their participation and roles in the social and community development.

There is a conflict between national and local interest as well. Overlapping in function of various agencies involving in marine and coastal resources management, poor coordination among them and weak enforcement of law and regulations have all contributed to this conflict. The case of Xuan Thuy national park, a RAMSAR site in Nam Dinh province best illustrates this conflict.

3.3 National state of knowledge

There is a well developed body of knowledge about ecosystems and their services in Vietnam, compiled primarily by research institutions and individuals. The information about these services is usually broken down to the regional and local levels. Updated information is available in hard copy and Vietnamese languages. Only limited number of information are ready in English language and in a soft version.

More than 200 coral sites have been surveyed along Vietnam's coast over the last 10 years. Some research organisations are devoted to wetlands and mangrove research, such as MERC. Both the scientific and local communities are aware of the changes to mangrove ecosystems. However, the studies on the processes underlying these changes are limited and tend to focus on the reduction of fishery production and the change of soil.

There have been reports of large-scale seagrass decline at 17 locations in Vietnam, almost all of which were attributable to human-induced disturbance. Trends for recovery remain unknown.

Most of the research was done within a scope of a project or a certain area, thus, it is not possible at the moment to know about all services at national level. Most of the information about these services remain at research level, not yet available to policy makers and general managers.

Poverty has also been studied in coastal areas - mainly at the district level; however, the data and information has been no longer updated. There is limited analysis regarding the linkage between ecosystems services and poverty in coastal areas. General information about the access by the poor to various ecosystem services is available at the case specific level, creating an incomplete national picture.

3.4 Key knowledge gaps

i. Information available on the ecosystems services have been remained at research and academic level, not yet updated or interpreted for other important stakeholders such as managers, policy makers and community members.

Policy makers at various levels, from national to provincial and local levels all need to first understand the ecosystems services, how they work, how they link with poverty and factors that influence their functioning. Many decisions relating to natural resources managements are made based on administrative or political aspects without sound scientific justifications. This is also due to lack of up to date information.

Coastal managers also need to see the linkage between the ecosystems services and poverty so that their work can be well harmonised. Sometime their management is based on the research results. But researchers have different focuses when studying coastal ecosystems. They neither do not often integrated natural and social sciences perspectives nor expound on the relationship between the two. While other indirect factors come from ecosystem services such as mitigation of climate change through absorption of CO_2 in the seawater or shoreline protection values are overlooked.

The poor coastal people themselves also need to see the linkage between their livelihoods and the services that ecosystem services provided. This awareness will help them to see other longer benefit of ecosystems such as regulating and supporting rather than just a short term and visible services like provisioning. Local people will only committed to protect the ecosystems once they well understand that they link to their own livelihoods and that all the community is also committing to management.

Any intermediate agents such as NGO or community based organisations who work in the coastal areas also need to fully understand such linkages.

ii. Knowledge of the poverty in the coastal zone is limiting and outdated

The poverty in coastal areas in broader context of social development and justice needs to be studied thoroughly. Specifically, what factors facilitate or prevent the poor from accessing ecosystem services, how to promote/limit these factors? From the sectoral and intersectoral points of view?

Furthermore, the adaptive capacity of key stakeholders to address the issue mentioned above needs to be elucidated.

iii. Knowledge of the linkages between ecosystems services and poverty in the coastal areas of Vietnam is limiting

The quantitative data to demonstrate the linkages between ecosystems services and poverty is still limited and a major study on increasing the access of poor people to benefits from ecosystem services should be conducted.

Future research needs to analyse in depth other aspects of ES and poverty alleviation within the context of specific provinces and in particular address the question of how people employ ecosystem services aside from the capture fishery? (For example: fishers may use coral reefs for supporting eco-tourism; aquaculture as an alternative to capture fishery).

Furthermore, other factors should be incorporated into the assessment of poverty alleviation such as distance from main land (offshore islands), distance between the fishing communities and the city/town, infrastructure influencing the transportation of goods, etc. Very few previous studies deal with the linkages between the reduction of ecosystem services (eg. typhoons,– floods) and the poverty conditions of fisher communities in the coastal lagoons of Vietnam. Since 80% of the population depends on wetlands where lagoon system provides most services, it is need to conduct such studies.

All these needs of understanding of the ecosystem services and their linkage with poverty in coastal areas of Vietnam are not met at the moment.

3.5 Key policy options

Ecosystem based management approach to the use and management of natural resources need to be promoted in Vietnam. Most of management decisions are made based on administrative or political aspects which are not good for natural resources management. Any province or district when making decision on developing certain economies need to base on the services that the ecosystems existing in their location could provide and respect the rule of nature.

Co-management in the fisheries sector should be strengthened by institutionalizing the models from pilot activities at the national level. Since most of the poor identified in the coastal areas of Vietnam are engaged with fisheries, the way fisheries are managed need to be improved. The top down and central management does not work well and only community participation also is not enough. Thus, co-management of fisheries resources need to be promoted and leveraged to policy level.

Non fisheries options should be sought when confronted with low livelihood resilience. Near shore resources are recorded to be depleted and fishing efforts are encouraged to be reduced in Vietnam. Thus, options to alternative livelihoods are encouraged to seek, However, other options outside fisheries need to be found. The adoption of other sectors like IT, tourism or services should be studied to help the future generation of fishers to convert their way of making living.

Integrated coastal zone management (ICZM) should be promoted at both policy and practical levels. Sectoral management sometimes creates severe conflicts in the coastal areas as interests differ. A mechanism supported by a sound scientific justifications and a balance of economic and conservation purposes should be in place to ensure a sustainable development of the vulnerable coasts. ICZM was piloted in some provinces of Vietnam and need to further promoted at national level and concretized at local levels.

A Public Private Partnership model should be promoted to invest in further studies of the linkages between ecosystems services and poverty. Burden to government need to be reduced by promoting the investment from private sector. Business taken services from ecosystems need to pay back to those who are dependant on these resources. This philosophy works in many places and need to be promoted in coastal areas of Vietnam. The government encourages the development of marine and coastal economies. It needs to create policy to engage others stakeholders to invest and benefit from their investment in a sustainable way.

3.6. Matrix of ecosystem services, trends and interactions

Ecosystem Service Type	Ecosystem Service	Ecosystems involved	Poverty Link	Trends & drivers	Trade-offs	State of knowledge/gap	Policy options
Regulating	Protection beaches/coastlines from storm surges, floods, and waves Reduction of beach and soil erosion Formation of beaches and islands Land stabilization: trapping sediments Water quality maintenance Climate regulation	MANGROVES CORAL REEFS SEAGRASS BEDS	Coastal flooding Coastal erosion Changes in ecosystem productivity Sea level rise	Reduced ecosystem area leading to reduced protection function, affecting the poor strongly. Demand for regulating services increased **Direct:** Human activities- convert mangrove and lagoon area into aquaculture Human activities destroy, reduce and weaken coral reefs Climate change **Indirect:** Lack/Low awareness Poor planning Weak enforcement	Economic development vs ecosystem protection Use conflicts between aquaculture and other uses (mangrove removal), destruction of coral reef)	Limited information available on regulating services of ecosystems Total Economic Value is available at regional and local levels.	Increased awareness of protection function Valuation in monetary terms Integrated Planning
Provisioning	Fisheries for food Fisheries for aquarium trade Aquaculture for food and aquarium	MANGROVES CORAL REEFS SEAGRASSES LAGOONS TIDAL FLATS	Near shore overfishing and destructive fishing Low resilience of livelihoods Poor management of resources	Nearshore fishstock reduced significantly and low resilience in short term Increasing demand, mainly for capture – small scale fishery and aquaculture Used extensively by the poor: 28 coastal provinces, 20 million people directly and indirectly dependant Food security Directly affecting the jobs and income of 8 million people	Capture fishery vs aquaculture Offshore exploitation vs nearshore Rich vs poor Long term vs short term goals Industrial vs artisanal fisheries	Availability of information about provisioning services - but only at regional and local levels. Available info on poverty conditions in areas where provisioning services are provided, but the linkage between the two is not analysed Poverty status data is not updated (dated back nearly a decade) Mainly on fisheries aspects	Integrated coastal planning Co-management of fisheries Ecosystem based approach - Restoration of habitat Fair and Sustainable trading Non-fisheries options.

Ecosystem Service Type	Ecosystem Service	Ecosystems involved	Poverty Link	Trends & drivers	Trade-offs	State of knowledge/gap	Policy options
				Reduced quality of marinelife			
	Pharmaceutical products Building materials Jewelry and other decorations Fuel-wood Traditional medicines	MANGROVES CORAL REEFS		Harvesting is increasing/decreasing in response to demand and supplies	Provision of this service negatively affects: wildlife habitat coastal protection etc		
Cultural	Coastal tourism and recreation Spiritual, aesthetic appreciation	CORAL REEFS SEAGRASS BEDS LAGOONS MANGROVES TIDAL FLATS	Marine and coastal eco-tourism Marine tourism	Growing number of thriving tourism related enterprises that are located in reef-based areas which enables tourists to enjoy activities	Economic interests vs, conservation Social status of	Limited information and understanding of status, trend and dynamics	Community based eco-tourism Public - Private

Ecosystem Service Type	Ecosystem Service	Ecosystems involved	Poverty Link	Trends & drivers	Trade-offs	State of knowledge/gap	Policy options
	Education		2% of total income from tourism (Khanh Hoa province) Low access by the poor	such as diving, snorkelling, bird-watching & serve as scenic picnic grounds **Direct:** • Demand increasing • Limited capacity and skills • Poor support services **Indirect**: • Poor planning • Improper investment	the poor		Partnerships Education
Supporting	Cycling of nutrients Nursery habitats Island/beach /soil formation Primary production Maintenance of biodiversity	MANGROVES CORAL REEFS SEAGRASS BEDS LAGOONS TIDAL FLATS	Climate change: Change in types of species Change in capacity of nursery habitats Destructive human activities: Reduction of nursery habitat coverage	Maintenance and restoration **Direct:** Climate conditions **Indirect:** Lack of awareness Week enforcement	Short term vs long term goals Rich vs Poor	Basic biophysical info available at regional levels. Limited link to whole ecosystems and their services	Awareness raising on interactions between ES and poverty alleviation Public Private Partnership

Annex 1. Key ecosystem changes and its impact on ES and poverty in Vietnam

NO	ISSUES	ES-POVERTY LINK (positive and negative links)		TYPE OF INFORMATION/ VARIABLE	LEVEL	SOURCES OF INFORMATION
		ES	POVERTY			
1	Climate change - important issue: 25 million people in coastal zone will be affected) - pick sub-issues from vulnerability map and guidelines	Coastal flooding; Sea level rise; Changes in productivity and nutrient cycling; Biodiversity reduction; Focus on disasters	Human impacts: Death; Loss of property, crop and domestic animals; Infrastructure destruction; Diseases; Income reduction; Vulnerability	- Temperature increase; Change in rainfall pattern/SLR; - Disaster/hazard (floods, droughts, storms,..): frequency and intensity; - Change in resource use pattern; - Demography	National and local Local and region Local Local	CERED; MONRE, IPCC, NIO. VEPA, IMHE, MARD MONRE, MARD MCD, NCPFP,
2	Reduction of Habitats	Pollution of coastal zone Salinity intrusion; Mangrove clearing; Coral reef and sea-grass coverage reduction; Declining coastal productivity;	Reduction of income source from fishing, aquaculture, agriculture and forestry; Polluted environment; Movement	- Water and soil quality; - Quantity of rubbish - (waste) per km of coast; - Upstream source of water pollution - Number of oil spill cases; - Area, location and quality(size, biodiversity, density) of mangrove, coral reef and sea-grass coverage; - Production of output market; - Fishing and aquaculture	Provincial Local Local National National and Local Provincial National	VEPA, DONRE VEPA, DONRE VEPA, DONRE MONRE, MONRE, MCD, NIO, MARD, IUCN, WWF, UNEP, MERC, IMER MARD, VEPA MARD, NIO, WWF

NO	ISSUES	ES-POVERTY LINK (positive and negative links)		TYPE OF INFORMATION/ VARIABLE	LEVEL	SOURCES OF INFORMATION
		ES	POVERTY			
				tools/methods; - Aquarium fishery data - Number of households in each period	Provincial Local	NIO, MARD GSO, Local Statistics Office
3	Near-shore over-exploitation and destruction of natural resources	- Destructive/ unsustainable fishing leads to significant overexploitation and declining resources - Coral reef coverage reduction, natural material extraction; ornaments - Biodiversity degradation, - High risks from environmental threats (storm, typhoon…)	- Local people heavily dependent on ES and lack of diversification in livelihoods, low education levels - Decreasing fishing productivity and income of fishermen, changing in fishing methods and gears, high possibility of losing jobs	- Fishing method and equipment - Change in CPUE; - Horsepower (boat capacity) - Distribution of labor force in jobs; - Local consumption pattern - Quality and coverage of coral reef - Ornamental trade - Basic data of species	Local Local Provincial Local Local Local, Region Local National	MARD, VEPA, PPC VIFEP, ADB, WB MARD, MARD PPC, MARD, NIO, WWF UNEP,IUCN, WWF, MARD, MCD, MARD, MONRE, NIO, WWF

NO	ISSUES	ES-POVERTY LINK (positive and negative links)		TYPE OF INFORMATION/ VARIABLE	LEVEL	SOURCES OF INFORMATION
		ES	POVERTY			
4	The low resilience of livelihood	- Change and vulnerability of Ecosystem because of environmental shocks such as disasters, forest fire, human activities, increasing temperature, oil spills, migration, water quality etc.	- Principal activities in livelihood having high risks (agriculture, fishery, aquaculture) - The poor having low economic conditions - Low health awareness increase vulnerabilities from shocks	- Population density and growth of population - Structure and distribution of labor force) - Biodiversity - Productivity of resources - Stage of income, care health, education. - Frequency and intensity of local environmental shocks - Management to the shocks and recovery in local	Local Local National Provincial Local Provincial Local	PPC, NIO, GSO, MARD, LMPA-DANIDA PPC,WWF, UNDP, MARD MARD, MONRE MONRE, MOH, MOET MONRE, MARD MONRE, MARD

NO	ISSUES	ES-POVERTY LINK (positive and negative links)		TYPE OF INFORMATION/ VARIABLE	LEVEL	SOURCES OF INFORMATION
		ES	POVERTY			
5	Weak Coastal Management	- Unsustainable Ecosystem - Pollution from human activities especially Industrial pollution	- Conflict in using coastal resources: fishing, tourism, extracting oil and mineral, sea traffic. - Lack of policies support the poor in using resources properly - Lack of coordination among stakeholders - Lack of co-management	- Institution and policies in ICZM - Stage of participatory management - Sources support the poor. - The members participate in ICZM	National	MPI, MARD, MONRE MPI, MARD MARD, MONRE MPI, MARD, MONRE

NOTE:

ADB: Asian Development Bank

CERED: Centre of Environment Research Education and Development

MARD: Ministry of Agriculture and Rural Development

MCD: Centre for Marinelife Conservation and Community Development

MONRE: Ministry of Natural Resources and Environment

MERC: Mangrove Ecosystem Research Centre

DONRE: Department of Natural Resources and Environment

GSO: General Statistics Office

IMHE: Institute of Meteorology, Hydrology and Environment

IMER: Institute of Marine Environment and Resources

IPCC: Intergovernmental Panel on Climate Change

IUCN: International Union for Conservation of Nature.

MOH: Ministry of Health

MPI: Ministry of Planning and Investment

MOT: Ministry of Transport of Vietnam

NCPFP: The National Committee for Population and Family Planning

NIO: Nha Trang Institute of Oceanography

PPC: Province People's Committee

UNEP: The United Nations Environment Programme

VEPA: Vietnam Environmental Protection Agency

VIFEP: Vietnam Institute of Fisheries Economics and Planning

WWF: World Wildlife Fund.

WB: World Bank

Annex 2. Poverty rate in coastal provinces and districts of Vietnam

Source: International Food Policy Institute and Institute of Development Studies, 2003. Poverty and Inequality in Vietnam: Spatial Patterns and Geographic Determinants.

Poverty rates (upated 1999)

No	Region	Name of Province	Poverty rate	Name of District	Poverty rate
			Overall P0 %		P0 %
1	Northern Vietnam	Hai Phong	29	Hai An	31.2
				Cat Hai	27.5
				Do Son	21.3
				Kien Thuy	39.8
				Tien Lang	41.1
				Bach Long Vi	19.4
2		Quang Ninh		Cam Pha	19.0
				Ha Long	12.7
				Mong Cai	
				Hoanh Bo	47.5
				Hai Ha	
				Dam Ha	
				Tien Yen	63.0
				Van Don	48.4
				Yen Hung	46.9
				Co To	48.8
3		Thai Binh		Thai Thuy	36.8
				Tien Hai	37.4
4		Nam Dinh	35	Giao Thuy	37.8
				Hai Hau	37.1
				Nghia Hung	40.3
5		Ninh Binh		Kim Son	38.3
6		Thanh Hoa		Hau Loc	45.4
				Hoang Hoa	40.2
				Nga Son	42.1
				Quang Xuong	43.5
				Tinh Gia	48.7
				TX. Sam Son	32.7
7	Central Vietnam	Nghe An		Dien Chau	43.9
				Nghi Loc	40.9
				Quynh Luu	49.6
				TX Cua Lo	25.5
8		Ha Tinh	45	Cam Xuyen	47.0
				Can Loc	48.6
				Ky Anh	49.3
				Nghi Xuan	43.0
				Thach Ha	47.8
9		Quang Binh	47	Bo Trach	46.1
				TX Dong Hoi	18.2
				Le Thuy	49.1
				Quang Ninh	47.5
				Quang Trach	47.3

No	Region	Name of Province	Poverty rate	Name of District	Poverty rate
			Overall P0 %		P0 %
10		Quang Tri		Gio Linh	59.1
				Hai Lang	56.6
				Trieu Phong	56.9
				Vinh Linh	40.0
				Con Co	
11		Thua Thien Hue		Huong Tra	55.1
				Phong Dien	58.0
				Phu Loc	62.3
				Phu Vang	55.9
				Quang Dien	56.8
12		Quang Nam		Dien Ban	32.5
				Duy Xuyen	33.8
				TX Hoi An	30.8
				Nui Thanh	42.5
				TX Tam Ky	34.1
				Thang Binh	41.1
13		Da Nang	16	Hai Chau	7.1
				Lien Chieu	33.9
				Ngu Hanh Son	15.5
				Son Tra	16.0
				Thanh Khe	10.1
14		Quang Ngai		Binh Son	47.3
				Duc Pho	41.5
				Mo Duc	37.7
				Son Tinh	42.7
				Tu Nghia	41.3
				Ly Son	50.6
15		Binh Dinh		Hoai Nhon	38.9
				Phu Cat	45.5
				Phu My	48.2
				Quy Nhon City	18.4
				Tuy Phuoc	39.9
16		Phu Yen		Song Cau	55.3
				Tuy An	51.2
				TX Tuy Hoa	25.9
				Tuy Hoa	34.5
17		Khanh Hoa	33	Cam Ranh	36.6
				TP Nha Trang	15.4
				Ninh Hoa	40.9
				Van Ninh	49.6
18		Ninh Thuan	53	Ninh Hai	59.5
				Ninh Phuoc	63.6
				TX Phan Rang-Thap Cham	31.8
19	Southern Vietnam	Binh Thuan	45	Bac Binh	59.2
				Ham Tan	46.1
				Ham Thuan Nam	54.5
				TX Phan Thiet	27.3

No	Region	Name of Province	Poverty rate	Name of District	Poverty rate
			Overall P0 %		P0 %
				Tuy Phong	48.7
				Phu Quy	57.2
20		Ba Ria - Vung Tau		Con Dao	6.8
				Long Dien	
				Dat Do	
				Tan Thanh	13.1
				TP Vung Tau	4.3
				Xuyen Moc	16.2
21		Ho Chi Minh City	5	Can Gio	
22		Tien Giang		Go Cong Dong	30.2
23		Ben Tre	32	Ba Tri	39.6
				Binh Dai	35.7
				Thanh Phu	42.1
24		Tra Vinh		Cau Ngang	45.4
				Chau Thanh	44.6
				Duyen Hai	42.6
25		Soc Trang		Long Phu	41.3
				Cu Lao Dung	
				Vinh Chau	51.1
26		Bac Lieu		Dong Hai	
				TX. Bac Lieu	23.8
				Vinh Loi	39.5
27		Ca Mau		Nam Can	
				Phu Tan	
				Dam Doi	36.1
				Ngoc Hien	35.1
				Tran Van Thoi	36.5
				U Minh	38.0
28		Kien Giang	40	An Bien	42.3
				An Minh	46.3
				Chau Thanh	42.0
				Ha Tien	40.8
				Hon Dat	47.9
				TX. Ha Tien	36.3
				TX. Rach Gia	21.3
				Kien Hai	50.0
				Phu Quoc	36.6

ANNEX 4 - COASTAL AND MARINE RESOURCES OF EAST MALAYSIA

1. Introduction

Malaysia consists of two regions separated by the South China Sea - Peninsular Malaysia (West Malaysia) and East Malaysia. East Malaysia occupies the north and west region of Borneo and comprises two of Malaysia's 13 states – Sarawak and Sabah (figure 1). While East Malaysia is less populated and relatively less developed than Peninsular Malaysia, its land mass is larger and has notably more natural resources.

Sarawak is the largest state in Malaysia. The state stretches for some 750 km along the north east coastline of Borneo, interrupted in the north by about 150 km of Brunei coast. The coastal region is rather low lying flat country with large extents of swamps and other wet environments.

Sabah is the second largest state in Malaysia and with the longest coastline of approximately 1,800 km. Sabah borders the South China Sea on its west coast, the Sulu Sea on its north-east coast and the Celebes (Sulawesi) Sea on its south-east coast. Most of Sabah's landscape is dissected and covered with tidal swamps and freshwater swamp areas.

Sarawak and Sabah has some of the world's most important and diverse coastal and marine ecosystems. Some of this includes mangroves forests, coral reefs, seagrass and algal beds, estuaries and lagoons, sandy beaches and mudflats, shallow coastal and deep of shore seas, and fauna and flora resources. These ecosystems are most commonly utilized or /and exploited for (1) fishery (catching of resource, aquaculture and industry involving the processing of resource); (2) coastal agriculture; (3) mining of sea minerals; (4) land reclamation; (5) coastal development/urbanization; (6) tourism and recreation; (7) harbour facilities and shipping; and (8) defence.

1.1. Coastal and marine resource governance

Both Sarawak and Sabah voted to become part of the new Federation of Malaysia in 1963. As states of the Federation, Sabah and Sarawak retained a higher degree of local government and legislative autonomy when compared to other states in Peninsular Malaysia (West Malaysia). However, the challenge in creating an integrated and cooperative management in managing the coastal and marine resources still remains.

The management of coastal and marine resources is a complex one which involves three levels of authorities, namely the federal government, the state governments and the local authorities. The federal government is responsible for making and implementing the country's policies, while the state governments have the mandate and authority in all matters concerning land in the coastal area and handle all matters concerning the development and use of land. The local authorities such as the district office and the municipal council carry out various development projects under the guidance of the state governments.

This tiered system provides a management platform that is broader and able to include all issues concerning resource use, but it is also capable of causing dichotomy among the three authorities. This system is also capable of creating a conflict of interest, especially when there is the need to conserve and protect a resource, while at the same time to develop and use that resource.

In addition, the management of coastal and marine resources requires laws and enforcement that are comprehensive, integrated, stable and systematic. Laws and enforcement which assist and control development, management and use of coastal and marine resources involve many agencies and jurisdictions. For example, in the nation's waters, the enforcement agencies involved are the Marine Department, Fisheries Department, Royal Malaysian Navy, Customs Department, Immigration Department, and the Marine Park Section. On land, the enforcement agencies are the Department of Environment, district and municipal councils, Ministry of Tourism, PERHILITAN, and Department of Town and Country Planning. In terms of administration, Malaysia has various laws, regulations and guidelines that control activities in coastal and marine areas. The challenge is to integrate and create cooperation that is enduring and strong among all the enforcement agencies in the country.

As of now, a number of mechanisms have been implemented to strengthen integration and cooperation among the three levels of authorities. For example, for the management of marine park resources, the National Advisory Council for Marine Parks was formed to provide the platform for making decisions regarding the management and development policy of marine parks in an integrated manner. The representatives of this advisory council include those from the federal government, state governments, local authorities, NGOs, marine research agencies, local universities and the private sector.

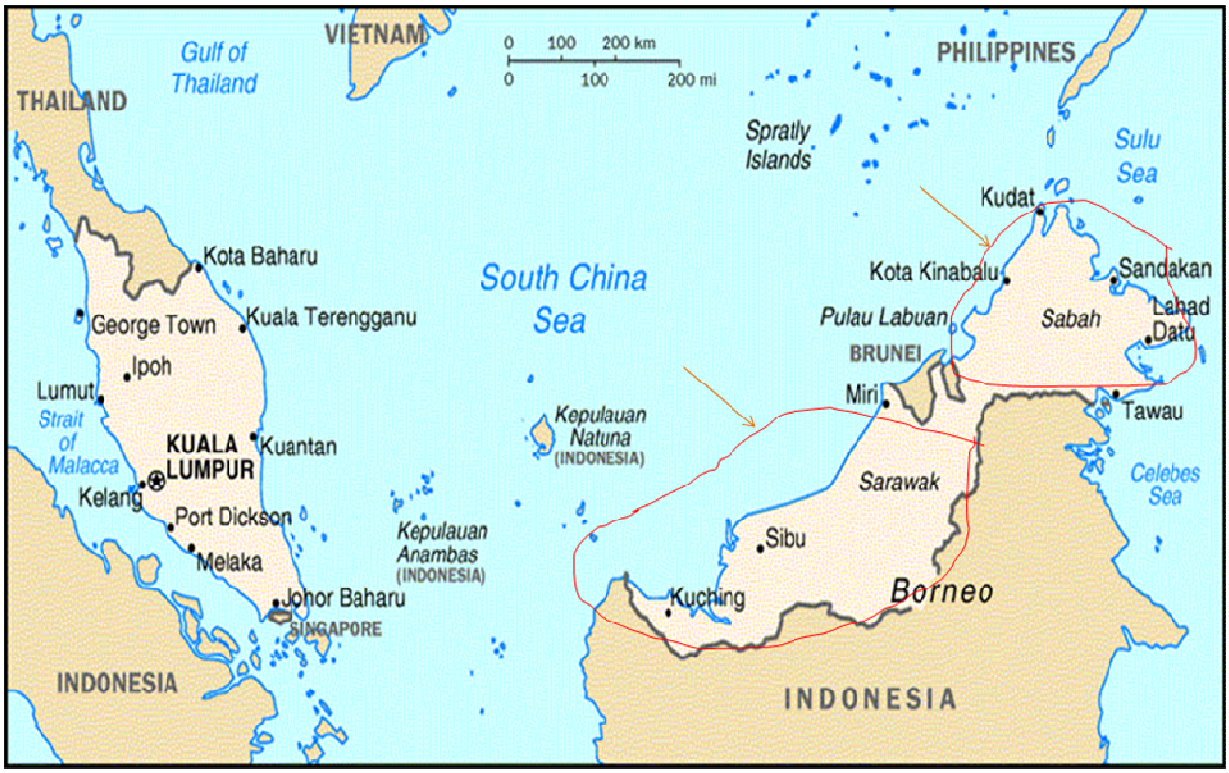


Figure 1: Location of Sabah and Sarawak of East Malaysia, downloaded from http://www.globaloceans.org/icm/profiles/malaysia on 13 April 2008

2. Status of Coastal and Marine Resources

2.1 Mangrove Forests

Sabah has the largest mangrove area (3,654 km2), more than three times that of Peninsular Malaysia (Ridzwan and Alex, 1997). Clear-cutting of mangrove forests in Sabah has been banned since the 1980's.

Mangroves are ecologically important as spawning and nursery areas for many of the aquatic species of economic importance. Many species, including some fish, crustaceans, migratory and resident water birds are ecologically dependent upon mangroves and their surrounding areas for all or part of their life-cycles. The extent of mangrove areas is one indicator of the state of the coastal environment that will influence fish productivity. Mangrove ecosystems are also important for regulation of natural processes which in turn will leave the land more fertilized and firm, hence, reducing the possibility of coastal erosion.

The economic potential of mangrove forests in East Malaysia largely stems from their direct use but the indirect use of mangrove supported resources is also of considerable importance to communities. The uses are based on (1) forest based products; and (2) marine and non-marine products which directly or indirectly contribute to the livelihood of communities living around the mangrove forests. A case study of the Sarawak Mangroves Forest Reserve valued mangroves through its economic support to the marine fisheries sector at US$21.1 million p.a. and can provide up to 3000 jobs, timber products worth

US$123,217 p.a., and a tourist industry worth US$3.7 million p.a (Bennett and Reynolds, 1993) to the livelihood of the community living around the reserve.

The current trend of mangrove forests services in Sabah and Sarawak has been summarised into four categories (table 1).

Past and present estimates of mangrove areas in Sarawak and Sabah are hard to obtain. However, according to a 1999 published information by the Tropical Research and Conservation Centre (TRACC) in their website, ariel views conducted for all the states of Borneo (which includes Kalimantan and Brunei besides Sarawak and Sabah) indicated 50 to 80 percent of the mangroves have been lost in the last 20 years.

This is in line with the high demand for mangrove woodchips in the 1960's to 1980's which was largely exported to Japan to feed their growing construction, rayon and paper industries. From 1971 to 1986, it was estimated that in Sabah about 70,000 ha of mangroves were consumed, an average of 4, 600 ha cleared each year to meet the demand of this new export based industry (Sabah Forestry Department, 2006). In Sarawak, 1,600 ha were clearcut annually. However, due to international environmental pressure and a shift of focus in the state Department of Forest, the production of mangrove woodchips were completely halted in 1995.

In recent years, there has been growing threat to the survival of mangroves and other coastal vegetation specifically along the coast of Sabah. This is due to the changes to the hydraulics and water quality regime caused by large scale coastal reclamation projects. The material placement phase of reclamation is of concern since currents could transport and deposit sediments on mangrove areas leading to their suffocation (Ghazali, 2006).

Table 1: Current trend of mangrove forests services in Sabah and Sarawak of East Malaysia

Type	Mangrove forests services
REGULATING	increase in coastal erosion due to coastal reclamation activities protection of coastal areas and agricultural land from waves, storms and flood increase of housing and coastal resort (including golf courses) development projects
PROVISIONING	subsistence and commercial fisheries commercial ciggratte cover building materials aquaculture ponds weaving material fuelwood fruits honey
CULTURAL	eco-tourism protected area (MPA) greenery to the village environment
SUPPORTING	shelter and breeding ground for prawns, crabs, cockles and various fish species shelter for birds reduced land fertility

Source: Compiled from Bennett and Reynolds (1993); Yusoff, Shariff and Gopinath (2006); Juin, Yangkat and Laugesen (2000).

In Malaysia, it has been suggested that a minimum of 5 percent of mangroves (30,000 ha) should be conserved as National Parks or other forms of protected areas. Progress towards this ambitious aim has been made, especially in Sarawak where in recent years there has been a better understanding and awareness of the roles of mangroves. In Sarawak approximately 2500 ha of mangroves are formally protected within various national parks and another 10,000 ha are in the process of being gazetted. These conservation gains are significant but unfortunately are dwarfed by the huge areas that have been converted and land-filled for industrial and residential development.

2.2 Coral Reefs

Southeast Asia is considered to be the global epicenter for coral reefs to flourish. Almost 100,000 square kilometres of coral reefs, equivalent to 34 percent of world's total, which accommodates over 600 of the 800 reef-building coral species in the world, can be found in this part of the region. Out of this figure, about 350 coral species inhabit Malaysian waters, with Sabah containing more than 75 percent of the country's reefs (Nasrah, 2005).

The coral reefs in Malaysia play an important global role as a genetic pool with the presence of marine life biodiversity that is rich, extensive and unique. For example in Malaysia, there are approximately 450 coral reef fish species, particularly those with commercial value as *Pomacentridae* (Damselfish) breeding and growing within the reefs . A 1991 Asian Development Bank study indicated that reef species in western Sabah account for 25 percent of the total fishery catch (cited in Yusoff, Shariff and Gopinath, 2006) pointing that while coral reefs continue to provide economic opportunities, it also ensures the socio-economic independence of coastal communities. It is widely known that reefs act as a buffer, shielding inshore areas from the pounding of ocean waves. This to a large degree is protecting marine organisms and the trees growing within the mangrove forests, while reef in itself is providing the nutritional growth of mangrove swamps and sea grass.

The coral reefs' characteristic as a wave breaker also ensures that the beaches are not eroded and are therefore responsible for the attractive surrounding for sightseers, sunbathers, snorkelers and scuba divers, as well as providing a wealth of food resources for the local communities. In the last few years, there has also been growing extraction of medicinal compounds from coral reef plants and animals. Several important drugs have already been developed from chemicals found in coral reef organisms, such as 3'-azido-3'-deoxythymidine (AZT), which is extracted from a Caribbean reef sponge and used to treat HIV. Rare compounds from coral reefs have also produced remedies for cardiovascular diseases, ulcers and skin cancer. However, in East Malaysia, the extraction of medicinal compounds from surrounding reefs is still contained for traditional medicinal cures by the local communities.

The current trend of coral reefs services in Sabah and Sarawak has been summarised into four categories (table 2).

Table 2: Current trend of coral reefs services in Sabah and Sarawak of East Malaysia

Type	Coral reefs services
REGULATING	nutrient to mangrove swamps and sea grass wave breakers, shielding coastlines and beaches increase pressure due to growing number of hotel development projects and tourists
PROVISIONING	subsistence fishing cyanide fishing blast fishing *muro-ami* fishing trawling ornamentals for aquarium trade medicinal compounds to traditionally treat ulcers and skin problem building materials income from water-based-tourism
CULTURAL	recreational activity through snorkeling and scuba diving protected area (MPA)
SUPPORTING	shelter / habitat for marine species breeding ground for marine species

Source: Compiled from Nasrah (2005); Yusoff et al. (2006); Juin et al.(2000)

Coral reefs around the region are currently facing the biggest threats from activities either directly or indirectly linked to humans. In East Malaysia, 68 percent of the coral reefs are threatened by fishing practices that are damaging and unsustainable (Nasrah, 2005). Some of these include cyanide fishing, blast fishing, *muro-ami* (reef breakage to drive fish into nets) and overfishing.

In Sabah, most of the coral reefs showed signs of severe damage from unsustainable fishing practices. In a 1997 survey conducted in over 2500km of the coastline of Sabah by the Tropical Research and Conservation Centre (TRACC), it was found that only five out of 55 reefs had breeding sized adults for the most important commercial fish species (Oakley, Pilcher, Ismail, Mackey, Clubb, Enderby, Digges, Huet, Toh, Atack and Smith, 1997). It was also found that on bombed reefs, fish diversity has reduce to less than half and actual numbers of benthic living fish species were reduced to less than 10 percent. Surveyors found that the most valuable commercial fish, humphead wrasse and large groupers, were only found at the two reefs protected by ecotourism (Oakley, 1997).

A study done around the Bintulu region – an area of major producer of marine fisheries in Sarawak, indicated that a part of the coral reefs is being destroyed and some part has been totally destroyed due to trawling. This 2006 study results also proved that areas with very poor or poor coral reef conditions usually are the areas with high coastal development activities, while areas with good condition coral reefs are usually the areas with low or fair coastal development activities (Idris, Harah and Arshad, 2006).

Comparatively, in Peninsular Malaysia (West Malaysia), destructive fishing is not widespread due to higher enforcement and less dependence on coastal fisheries. In East Malaysia however, population increase has led to intensified catch of marine resources to support the escalating demands. The removal of large numbers of fish caused the reef ecosystems to become unsustainable. In addition, this led to more competitive organisms dominating on the reefs. Decreased yields forced many fishers to change their fishing methods in order to catch enough fish to meet their needs. In some areas, even juvenile fish are caught for sale.

The Department of Fisheries Malaysia has the responsibility to manage and ensure the value of coral reefs is sustained. They have established marine parks under a government directive in 1983 to conserve

and protect coral reefs for sustainable fisheries, tourism and research. There are currently 136 marine protected areas, containing 7 percent of the country's coral reefs (Nasrah, 2005). These national parks which are grouped together for better management are situated around 40 islands with 9 out of the 40 islands situated in East Malaysia.

2.3 Seagrass Beds

Malaysia's diversity in sea grass is demonstrated by its 10 genus and 14 species of sea grass, which places it as one of the country in the region with the highest diversity. There are 78 seagrass beds scattered throughout Peninsular and East Malaysia (Japar, Muta and Aziz, 2006). In East Malaysia, the most developed and diverse communities are found in the west and south-eastern coasts of Sabah and north-west of Sarawak, areas where urbanization is still minimal.

Seagrasses make up only a small portion of the marine ecosystem, however the physical settings and their interactive community within and from outside account for their high diversity. Like the mangrove swamp, the sea grass area acts as a breeding ground, nursery and sanctuary. In Sarawak, the known seagrass area of Punang-Sari-Lawas is especially important to a number of commercial fish species such as *Ilisha elongate*, locally known as "Tahai" which is harvested mostly by traditional fishes for subsistence and local sale. Uniquely seagrass areas are also important in ensuring the survival of a number of endangered mammals and reptiles. This includes the vulnerable dugongs or sea cows, seahorses and endangered green turtles. In Sabah, interviews conducted with fishers and local villagers have indicated that dugongs are encountered occasionally in Tunku Abdul Rahman Marine Park (Jaaman, 2000). During the nesting season, green turtles are found in groups along the coast of Pulau Selingan and Pulau Bakungan Kecil of Sabah. These areas are the nesting ground of the turtles and the presence of seagrass meadows in the vicinity may serve as feeding ground (Japar et al., 2006). Seagrass also serves as seasonal feeding ground for migratory wading birds such as some of the herons and egrets, notably near Lawas, Sarawak.

On the ecology side, seagrasses role in the stability of coastline morphology is understood despite the lack of in-depth studies focusing on the costal sides of East Malaysia. Seagrass is known to reduce soil erosion through its hold of sediments and the reduction of turbulence of water above the sediments. This hastens the sedimentation process and assists in the accumulation of mud and soil on the seabed. However, over the last few years the number of coastal development activities covering housing and tourism projects is increasing. One of the apparent environmental problems observed from this unchecked development is the eroding coastal areas in East Malaysia. Data in 2006 indicated that in Sabah, 18 percent of the coastline is being eroded, 11 percent is stable while the remainder is being monitored. While in Sarawak, 5 percent of its coastline is being eroded, 22 percent is stable, 15 percent is rebuilding and the remainder is being monitored (Ghazali, 2006).

The current trend of seagrass services in Sabah and Sarawak has been summarised into four categories (table 3).

Table 3: Current trend of seagrass beds services in Sabah and Sarawak of East Malaysia

Type	Seagrass beds services
REGULATING	Increase in soil erosion along the coastal areas increase pressure due to coastal development dredging and anchoring
PROVISIONING	traditional capture fisheries supporting local coastal population collection of peanut worms for fish baits gleaning sites for food collection, i.e.: sea cucumbers, gastropods and bivalves
CULTURAL	protected area (MPA)
SUPPORTING	feeding ground for dugong, green turtles and migratory birds shelter, habitat and nursery ground for an assortment of fish, shrimps, starfish, sea cucumbers, bivalves, gastropods and seaweeds (biodiversity) gleaning site for bivalves, gastropods, sea cucumbers and macroalgae

Source: Compiled from Japar et al., (2006); Yusoff et al. (2006); Juin et al.(2000)

Seagrass ecosystems are sources of food and yet they are continually threatened by human activities, causing their degradation and possible habitat loss. In Sabah, most seagrass ecosystems are popular gleaning sites for food collection mainly for fauna such as sea cucumbers, gastropods and bivalves which have left these resources in depleting stages. There are documentation of large scale illegal fishing along Pulau Selingan and Pulau Bakungan Kecil (Japar et al., 2006) of north-eastern coasts of Sabah using explosives which has caused major damages to associated seagrasses and other ecosystems including coral reefs.

Seagrass ecosystems are teeming with life, providing essential habitat for associated fauna and algal flora. In addition, given the importance of seagrass as a fisheries habitat, nursery and feeding ground, this relatively lesser known resource must be afforded the same priority as that of mangroves and coral reefs. Seagrasses contribute to the coastal fisheries resources and biodiversity which in turn are resources highly valued by the local coastal communities. On the other hand, continued human activities in the coastal areas threaten and cause degradation and habitat loss. However, the protection and conservation of seagrass resources is not confined to managing the seagrass areas themselves. As pointed out by Japar et al., (2006), the management of seagrass resources requires efforts directed towards identifying, understanding and solving the natural and man-induced changes to seagrass resources.

2.4 Marine fisheries

The marine fisheries sector in Malaysia has undergone rapid change during the past three decades. The remarkable development of the sector during the mid-sixties and seventies has resulted in a considerable increase in the number of fishing units, fisherfolk, motorized vessels and the expansion of total fish landings. One significant factor that provided considerable impetus to the fishery development during this period was the Government policy to eradicate poverty by improving productivity.

Rapid development and adoption of modern fishing technology in the sixties and seventies resulted in the dualistic character of the fishery sector in East Malaysia. The traditional fishery sector is typically small-scale, using vessels of less than 40 Gross Registered Tons (GRT) using traditional fishing gears. The inshore vessels operate within territorial waters twelve nautical miles from shore. The commercial sector uses larger vessels (greater than 40 GRT) that typically operate further offshore, using commercial gears such as trawls and purse seines. The proclamation of the 200 nautical mile Exclusive Economic Zone (EEZ) in the early eighties extended the fishery jurisdiction and expanded the resource base for East Malaysia. The development of offshore fishing was given greater emphasis. By issuing licenses, private entrepreneurs and inshore fishers were encouraged to invest in offshore fishing, which in turn increased the production capacity of marine fishery.

The improvements in fishing technology and productivity in the sixties and seventies had negative impacts on the fish stocks. By the eighties and early nineties much of the fish stocks, particularly in inshore areas were overexploited. A study by Tai and Kusairi (2001) indicated that the fishery resources in Sabah depreciated in eight years between 1980 and 1993. An analysis between levels of fishing effort and depreciation for each species group including pelagic, mollusks, demersals and crustaceans indicated the fishing effort in Sabah is high. As a result, since the nineties fishery policies were vigorously advocated towards resource conservation and management of the fishery resources on a sustainable basis. During this period, inshore fishing fleets and the number of inshore fishers were reduced and consolidated in order to achieve the optimal level consistent with the sustainable resource objective.

The fishery, although multispecies, is comprised predominantly by pelagics and reef species. In terms of consumption, Malaysians consume 60 to 70 percent of their animal protein from marine fishes (WWF, 2001).

Besides fishing effort, the status of marine fisheries is also very much linked to the status of the marine water quality and its general environment. All types of contaminants found in rivers and streams will finally be discharged into marine waters. One of the most severe threats around the coastline of Sabah and Sarawak, particular on the west coast, is the suspended sediment flowing from rivers. This blocks out the flow of light, a very much needed source for the growth and respiration of marine habitats. The deposited silts also provides unfavourable conditions for fish spawning, which has caused fish, crustaceans and invertebrates to migrate from affected areas due to respiration problems. Bacterial pollution is another growing problem in the coastal areas of Sabah and Sarawak due to illegal squatting areas which lacks proper sanitation system. For instance, the water at the coastal water around Likas Bay, in Sabah has been found to have a high level of E. coli count, exceeding the standards set by the Malaysian Department of Environment. The most prominent and visible threat to the marine resources of East Malaysia are the floatables such as plastics, cans, bottles and a host of other solid wastes, which are commonly found in the coastal waters. Not only floatables have a direct impact on soft bottom communities, they also have a very serious effect upon marine beach aesthetic, which is directly related to the tourism industry. The issue of floatables can be tackled through the use of debris collectors along coastal areas and at the mouth of the major rivers. Debris collection is, however, an expensive intervention, which has to be borne by the Government through the Local Authorities.

Currently the Department of Environment has proposed an integrated approach which includes imposing environmental tax on plastic bags, building houses for the relocation of squatters away from water ways and conducting environmental education and awareness programs to address the environmental challenges faced in sustaining marine fisheries.

3. Ecosystems and costal poverty

In 1970, more than half of all Malaysian households were living in absolute poverty. Today, less than five per cent live below the national poverty line. This is an enviable record, and is matched by tremendous progress in human development – health (including reproductive health), education and gender equality. These human development achievements reflect the government's strong commitment to long-term policies that have focused on growth with equity. But while Malaysia has made tremendous progress in reducing absolute poverty, there are still about 1.2 million Malaysians living below the national poverty line. In East Malaysia, the rural indigenous communities are the country's most impoverished groups, despite the abundance of natural resource wealth (Leete, 2007).

In Sarawak, poverty rates are relatively high where some 7.5 percent of households are living below the national poverty line. The bulk of them are rural dwellers, and among the poorest of the poor are those who live on the margins of Sarawak's forests and rivers – that is the indigenous communities. The indigenous communities face not merely disparities in income and wealth, but also challenges in accessing health and education.

In Sabah, more than a quarter (24 percent) of all households is currently living below the national poverty line income. Progress in poverty reduction and equity has been adversely affected by exceptionally high population growth rates. Comparatively, Sabah has the highest population growth rate, with numbers

increasing from just 410,000 in 1960 to more than 3 million in 2005. The share of Malaysia's population living in Sabah doubled from 5.6 percent in 1957 to 11.5 percent in 2005. No other state in Malaysia has increased its share by such a magnitude (Leete, 2007). The relatively high fertility of the indigenous communities has been augmented by very high levels of international labour migration, both legal and illegal, from neighbouring Indonesia and the Philippines (Leete, 2007) whom over time have become Malaysian citizens.

4. Conclusion

The ubiquitous and abundant supplies of marine and coastal resources in the past have resulted in minimal concern about their conservation and sustainable exploitation. In fact, in East Malaysia, these resources are continuously threatened by human activities such as overexploitation of living resources, massive land reclamation and development, discharge of harmful industrial and domestic wastes, and large energy development projects. Threats to the sustainability of these resources in the form of land-based and sea-based pollution are becoming serious and to certain extent are affecting the well-being of the people.

The manifestations of the disregard to the coastal and marine environment are already obvious, as evidenced by the frequent reports on water shortage, polluted rivers and seas, decrease in fisheries commodities, decline of aesthetic values in water-based recreational areas and decrease in biodiversity (Yusoff et al., 2006). Various laws and regulations have not been able to deter some of these ecosystems from being continually exploited on unsustainable basis.

However, since the last 2 decades, the directly concerned Ministries and Departments ,i.e.: Ministry of Natural Resources and Environment, Department of Fisheries, Department of Forestry, have been trying to bring together all stakeholders to protect these valuable ecosystems such that their resources would continue to provide life necessities for generations to come. Many of these agencies have on-going active preventive programs, such as the implementation of holistic environmental management, increased public education and the early use of efficient and cost-effective pollution control measures through research efforts and the acquisition of clean technology.

Perhaps, in-par with the progress of private service and manufacturing industries in Malaysia, these efforts by the Government should be complemented and supplemented by investments from the booming private sector to achieve a clean, healthy and productive aquatic environment for both present and future generations.

ANNEX 5 - INSTITUTIONAL ANALYSIS: PHILIPPINES

Summary questions:

a) What are the key institutions with capacity to generate knowledge on the links between ES and poverty?

University of the Philippines Visayas (UPV), UP College of Social Work and Community Development (CSWD), Philippine Institute for Development Studies, SEAFDEC and Silliman University- Angelo King Center for Research in Environmental Management (SUAKCREM), Philippine Institute for Development Studies

b) What are the key institutions with capacity to interpret and apply knowledge to promote the sustainable management of ES for poverty alleviation?

University of the Philippines Visayas (UPV), Philippine Institute for Development Studies (PIDS), UP College of Social Work and Community Development (CSWD), Silliman University-Angelo King Center for Resource and Environmental Management (SUAKREM)

While the institutions mentioned in (a) above can generate the knowledge through research, they have limited capacity to apply the knowledge, except as in the case of the university UPV, UP-CSWCD) through its extension and training programs. Those in a position to apply the knowledge generated through research will be government units and line agencies whose mandate includes poverty alleviation/ mitigation and/or ecosystems, specifically DENR, BFAR, NAPC, DSWD, Local Government Units. Related non-government agencies can also incorporate research results into their community development activities and their advocacies. These NGO's include: Tambuyog, Haribon, Institute of Social Action, CERD.

c) What are the main capacity needs in relation to 1) generation of knowledge on links between ES and poverty and 2) interpreting and applying knowledge to promote the sustainable management of ES for poverty alleviation?

1. Establishment of an interdisciplinary group to work together on the issues; Aside from this, there is a need to build capacity on more sensitive approaches for combining ecological and social information needs in gathering information, for example Scenarios building exercise, poverty and ES mapping, development of trans-disciplinary models in both quantitative and qualitative ways, etc.

2) Building or expansion of partnerships at local, provincial, national and multilateral levels, in governments, international organizations, NGOs, and the private sector, in research and development and implementation;

There is a need for line agencies personnel to acknowledge the need for them to seek and use research results in their operations. This will require some modicum of research training for these personnel. In relation to this, personnel capacity to generate research information from their regular field activities can also be built through training, and provides opportunity for a built-in monitoring of e.g. effects of interventions in poverty mitigation. In addition, LGU's, Academe/research institutes, NGO's and National line agencies and Stakeholder communities can be trained to improve their interagency collaboration and increase the importance of such collaboration in promoting sustainable management of ES for poverty alleviation. At present the link of sustainable management to poverty alleviation is not as FOCUSED, and not as INTEGRATED, as it should be. Improving their terms of engagement with each other can increase mutual understanding of their respective roles and dissipate mistrust and suspicion which is the case in many programs.

d) What are the possible strategies to address these needs?

1. Workshops and training for the working group on the links between ES and poverty and sustainable management of ES for poverty alleviation.

2. Documenting as case studies of already existing successful as well as unsuccessful experiences in linking poverty alleviation and ecological services. In the national workshop, it was the opinion that there exist already experience in ES for poverty alleviation but these are not well documented.

3. Support graduate programs and research (essays/special problem papers, theses and dissertations) which will further explore linkages and promote establishment of links and integration between ecosystem services and poverty alleviation (ESPA)

Table 1: Key institutions in ES and Poverty Alleviation in the Philippines

1.Organization/ institution	2.Responsibilities/Mandate	3. Main area: (ES, poverty, span poverty and ES?)	4. Power	5. Scale	Institutional capacities to generate and use scientific knowledge						
					6. Involved in generating scientific knowledge? Natural, social, interdisciplinary?	*7. What capacity does it have to generate this knowledge?*	*8. Does it use scientific knowledge? Natural, social, interdisciplinary*	*9. What capacity does it have to interpret and apply knowledge?*	*10. Which sources of knowledge does it have access to?*	*11. Where is this knowledge located?*	*12. Can other institutions gain access to the knowledge possessed by the institution?*
Philippine Institute for Development Studies	Develops and implements a comprehensive and integrated research program that will provide the research materials and studies required for the formulation of national development plans and policies - serves as a common link between the government and existing research institutions - establishes a repository for economic research information and other related activities	**Poverty and ES** - maintains three programs, namely, Research Program; Outreach Program; and Dissemination and Research Utilization Program - publishes researches/reviews that relate to poverty: economic, social, political, and environmental (Agriculture, Climate change, Natural Resources Management)	**High** - PIDS research is envisioned to help government planners and policy-makers in the executive and legislative branches of government - primary clientele consists of the network of agencies that make up the National Economic and Development Authority (NEDA)	**National**	**Yes**. Multidisciplinary and interdisciplinary It does research in several fields, inc economic, social, political, Environmental change, agriculture, climate change and natural resources management.	**High** It is able to access funds to undertake the studies and it is recognized as a research support to the country's national planning agency- NEDA.	**Yes**. Interdisciplinary It is a research institute that is best known for its economic research into development issues.	**Low** PIDS is a research agency, so it is a knowledge generator and does not implement programs on the ground. However, it can interpret knowledge in its fields of expertise	PIDS undertakes its own research and makes this available to users esp policy makers.	- internally and externally: PIDS coordinates with other researchers from various academic institutions and backgrounds; list of these institutions are found in their website	**Yes** - Their reports are available through publications. - has an online electronic database (*SocioEconomic Research Portal for the Philippine)* of completed and pipeline research studies related to economic development and policy making - researchers can also view some of the studies' full text
Department of Social Welfare and Development	Provide assistance to local government units, non-government organizations, other national government agencies,	**Poverty.** Community Services/poverty groups (across sectors, so not dedicated to ES)**:** *****Child Protective Services,	**High** DSWD is the major welfare national agency in the country. Its Head is a member of the President's cabinet. It sets	**National and regional (sub-national).** Central office and regional offices in the 13 regions (Field offices)	**No**. - focuses mainly in providing services for the poor, marginalized, and disadvantaged sector.	**Low** The DSWD is mainly staffed by social workers and are not tasked with research.	**Not known**. It utilizes statistics to locate its target groups which are the people in poverty.	**Low** On their own, social workers may not have much opportunity to read research findings. It would be a rare	The data base of the National Statistics Office and the poverty statistics provided through the related	**Internally,** in the case of internally generated statistics.	One would have to make a bureaucratic request for certain data, as it may not also be immediately in the format desired by data requestors.

	people's organizations, and other members of civil society in effectively implementing programs, projects and services that will alleviate poverty and empower disadvantaged individuals, families and communities for an improved quality of life	*Alternative Family Care, *Special Social Services for Children in Armed Conflict, Rehabilitation Services for Children in Conflict with the Law, *Services for Women in Especially Difficult Circumstances, *Neighborhood Support for Older Persons, *Self-Employment Assistance-Kaunlaran (SEA-K), *Tindahan Natin Project	policy, among other critical functions as noted below: - Registers, licenses and accredits individuals, agencies and organizations engaged in social welfare and development services, sets standards and monitors the empowerment and compliance to these standards - gives augmentation funds to local government units so these could deliver SWD services to depressed municipalities and barangays and provide protective services to individuals, families and communities in crisis situation - Formulates policies & plans which provide direction to inter-mediaries and other implementers in the development and delivery of social welfare & develop-ment services	of the country. But it is represented in local government: provincial and municipal. Its programs operate nationwide especially those services marked with (*) in column 3) - other services are limited to these regions: Field Offices VII, XI and NCR, Regions I, II, III, IV-A, VI, VIII, IX X, XI, CARAGA				staff who would be individually motivated and have the time to seek out knowledge from research.	national surveys are accessible to them. They may from time to time have studies done especially when externally funded projects has a research component . They also have their own field reports and internally generated statistics from the field, esp with regards monitoring of their projects.		

National Anti-poverty Commission (NAPC)	Several, including : - To act as the "coordinating and advisory body" that exercises oversight functions in the implementation of the Social Reform Agenda (SRA) and ensures that it is incorporated into the formulation of the national, regional, sub-regional and local development plans - To operate on the principle and strategy of institutionalizing the basic sector and NGO participation in the SRA management cycle - develop and promote microfinance, encouraging private and government financial institutions to open a special window for	**Poverty.** Focuses mainly on the poverty reduction program of the government. - includes Human Development Services (i.e. Health, Education, Peace and Order, Basic Social Infrastructures). It seems from one interview I had with their staff that there is a small component tackling coastal and fisheries groups, but I need to reconfirm this.	**High.** Its Head has subcabinet position, but currently is of high visibility as the Phil grapples with deep problems of increasing poverty. - composed of a government sector component, with (13) national government agencies and presidents of the four (4) Local Government leagues; and a basic sector component, with fourteen (14) sectoral representatives - lead agency and houses the coordinating secretariat of Kapit-Bisig Laban sa Kahirapan (KALAHI), the strategic framework and program for poverty reduction of the Macapagal-Arroyo Admin.. It provides policy	**National and regional (subnational) .** It is national in scope and NEDA regional offices serve as their secretariat in the regions, assisted by the Office of the Presidential Assistant in the Island. At the provincial level, the Governor appoints a Poverty Action Officer from his technical staff.	**No** - like DSWD, it only focuses on implementing national anti-poverty programs and projects of national government agencies	**Medium-High.** It generates data from the projects it implements, such as in project monitoring. It may subcontract research outside.	**Not known**. It would ideally have to use poverty data generated at the Natl Census in order to plan out its interventions. Although in actual operation this may not be the case. Other considerations like political expediency may be more influential.	**Low** (limited capacity) Its operation appears top-down where the central office in Metro Manila identifies the intervention programs in coordination with other agencies with capability to inplement.	It has documents on various projects and government efforts for poverty alleviation	**Internally**	**Yes**

	microfinance		review; targeting, planning and programming support; as well as monitoring and feedback mechanisms for KALAHI								
Silliman University-Angelou King Center for Resource and Environmental Management (SUAKREM)	Was established in response to the urgency of research, conservation, and protective management of marine and terrestrial environments in the country	**ES.** Focus mainly on issues of environmental concerns, specifically - Ecosystem Services: (1) promotes environment-friendly technologies to increase fishery production of coastal areas; (2) renders services to teachers and graduate students through lectures, workshops, short term training, and thesis advising; and (3) conducts consultancy services on environmental project evaluation and environmental impact assessment	**High.** SUAKREM is part of Silliman University. So its influence is as a respected research institution, consulted by both public and private when they see the need to. It has moral suasion.	Operates from the university based in the Visayas, but scope of work can be both local and national. collaborates with international and local research centers in Luzon, Visayas, and Mindanao	**Yes/Natural:** - through research done by the organization and its partner agencies and academic institutions	**High capacity** as it is staffed with highly trained (PhD's) academicians and scientist researchers	**Yes.** They are science-based.	It generates knowledge which it disseminates through publications and extention and training functions of the university.	Access to most sources of knowledge depending on the needs of their researches. To access information they need they would have to go to libraries other than their own, mainly in Metro Manila. Other research institutions and government agencies as well for internal publications. However access to journal articles, as with all Philippine universities is lower because of high cost of subscriptions to Current Contents on line and physical subscriptions.	Internally located – in their libraries and offices. Externally – in published books and journal articles	**Yes**- publishes newsletter periodically and is available in their website - website provide a list of researches (both on-going and published)

Haribon Foundation	Committed to nature conservation through community empowerment and scientific excellence - saving sites, saving species, working with people, and advocacy	**Poverty and ES** - conducts pioneering research on biodiversity and conservation; the organization uses the researches to advocate for environmental-friendly policy from government	Claims to be the pioneer environ-mental organization in the Philippines Positions itself to provide policy input and influence in conservation of sites through actual; projects in both terrestrial and marine ecosystems	**National** **-** it is recognized, both in the Philippines and abroad, as the pioneer in Philippine environmental conservation. Haribon joins birds and habitat conservation organizations worldwide in a global partnership called BirdLife International. Haribon is the Philippine partner	**No** (but the organization disseminates information through books published-based on scientific findings) - **publications include**: Books, Digital Media, and Haring Ibon magazine, all of which, aim to expand knowledge on conservation	Since most of the work of Haribon is advocacy, it has low capacity to generate such scientific knowledge unless it hires or contracts siceintists or researchers	**Yes.** It uses scientific knowledge in its advocacy --- using natural, social and interdisciplinary knowledge	**Low to middle** – in interpreting scientific knowledge **Middle to high** – in applying knowledge through their conservation projects	**Publications:** (1) Books - Philippine Biodiversity for Beginners - An Introduction to Resource Valuation: The Philippine Context - Biodiversity conservation		- list of books and other publications are found in their website
Marine Science Institute, University of the Philippines (UP-MSI)	UP-MSI seeks : 1) To generate basic information necessary for optimal & sustained utilization, manage-ment, and conser-vation of the marine environment and its resources; 2) To provide graduate-level	**ES**	Knowledge generation, policy advise,	Site specific, coastal	**Yes,** mainly natural, but occasionally interdisciplinary	**High** (it is recognized in the world as a major research institute in marine/coastal ecosystems	**Yes**, natural Interdisciplinary	**High** (it is recognized in the world as a major research institute in marine/coastal)	Database, own reports, published articles and books	Internally and externally (published articles and books)	**Yes,** academia and scientific communities, government and other sectors

	training and extension services to develop human resource require-ments in the marine sciences. 3) To develop appropriate & environmentally-sound marine-based technologies for industrial &economic development										
Tambuyog Development Center (Tambuyog)	An NGO that focuses on the declining fishery resources and unabated poverty in coastal communities through interdisciplinary research, creative information and education campaign, community organizing, community advocacy and constituency building	**Poverty and ES**: has gathered substantial amount of data on the political, social, and economic situation in coastal communities, and the status of various aquatic resources and the coastal environment - links biological with social, economic and political analysis, thereby, developing an alternative model or approach to development-community-	It is a recognized and respected NGO in area of Fisheries and community development. It is consulted in interagency programs. Its opinions are sought and listened to.	Operate through projects in sites including: Metro Manila (National Capital Region); Bicol Region (Region V); Central Visayas (Region VII); and Southern Tagalog (Region IV).	**Social, linking with biological and Interdisciplinary**	**High capacity**. Undertakes action research, community organizing and advocacy work.	**Yes**, it uses interdisciplinary approaches in its research and in undertaking its community programs.	**High capacity**. Their community involvement and projects apply perspectives drawn from research.			**Yes.** It has a regular newletter. The have publications which are listed on website and are available at selected special book stores.

		based coastal resource management (CBRM)									
University of the Philippines Visayas (UPV)	Premier Educational institution for fisheries and aquatic education, natural and social sciences. Its lead college is the College of Fisheries and Ocean Sciences. It undertakes instruction, research and extension especially for rural development.	**Poverty and ES.** The university undertakes interdisciplinary research through its faculty of Fisheries and of Social Sciences.	The UPV has the distinction from the Commission of Higher Education of being the center of excellence in Fisheries Education. Its fisheries scientists have led the national networks in various fields of fisheries research. It has moral suasion because of its academic prestige as the University of the Philippines, which has status of being the National University.	**National**, but based in the Visayas.	**Yes**, through the research functions undertaken by its large pool of PhD faculty and researchers in the natural , social and Interdisciplinary areas.	**High** capacity as it is staffed with highly trained (PhD's) academicians and scientist researchers	As an academic institution it uses science-based knowledge but also aware of the role of social and cultural contexts.	Through its vibrant extension and training functions it translates research findings into science-based interventions	Access to most sources of knowledge depending on the needs of their researches. To access information they need they would have to go to libraries other than their own, mainly in Metro Manila. Other research institutions and government agencies as well for internal publications. However access to journal articles, as with all Philippine universities is lower because of high cost of subscriptions to Current Contents on line and physical subscriptions	Internally and externally – the UPV libraries abound with various materials, while the various academic units also holds in-process or gray materials such as research reports. Various articles published in journals and books (authored or co-authored by UPV researchers can be accessed in those journals' website or bookstores	**Yes** through its publications
UP College of Social Work & Community Developme	University of the Philippines Social Action and Research for Development Foundation, Inc.	**Poverty**	As part of the University of the Philippines – Diliman Campus, CSWCD has been recognized	National, country's regions, site-specific	Social, interdisciplinary areas	**High.** It is staffed with faculty members and researchers who were trained with graduate	As an academic institution it uses science-based knowledge but also aware of the role of social and cultural	It generates knowledge which they disseminate through publications and extension and	It maintains its own library which is being updated subject to available	Internally and externally --- in its library and in articles and books published and	**Yes.** Just like other UP libraries, the CSWCD library is also open to other non-university or non-

nt (CSWCD)	**(UPSARDF)** assist the UP College of Social Work and Community Development (UP-CSWCD) to undertake, promote, and/or enhance research and action programs and projects on social development - Support programs and projects in social work and community development - Establish scholarships and professorial chairs in social work, CD and related fields - Conduct, sponsor or underwrite seminars, training programs, and conferences dedicated to the promotion, propagation, and enhancement of social development - Publish and distribute without profit research outputs of projects and research programs supported or undertaken		as provider of quality research and fora / seminars on social development and community development, which includes community-based coastal resource management (CBCRM) approaches			degrees and other special trainings	contexts.	training functions of the university.	resources on the university. As a unit of the university, it has internet access thereby making internet or web-based information accessible to its staff	distributed outside	UP users

Bureau of Fisheries and Aquatic Resources	Extension, policy input and research	**ES and poverty**	Provision of technical assistance, some knowledge generation	National and regional, site-specific	**Yes, Natural, social and interdisciplinary**	**Medium to high** (aside from several technical personnel, this insti.Contracts out research and studies with scientists and researchers	**Yes Natural, social and interdisciplinary**	**Medium to high** (aside from several technical personnel, this insti contracts out research and studies with scientists and researchers	Commissioned research, reports, database	Internally, externally (published or co-authored reports	**Yes**. Government Other users, Academe
Southeast Asian Fisheries Devt Center (SEAFDEC) - Aquaculture Department	Promote and undertake research on aquaculture relevant and appropriate to the region Encourage human resource development in aquaculture through training and extension Disseminate and exchange information in aquaculture	**ES and poverty**	Knowledge generation, policy advise, and some technical assistance	Regional (SEA) National and country's regions, site-specific	**Yes Natural, social and interdisciplinary**	**High** (as a SEA research organization, it as several well-trained scientists and researchers)	**Yes.** Natural, social and interdisciplinary	**High** (it is recognized in SEA and the world as a major research institute in aquaculture and marine/coastal)	Database, own reports, published articles and books	Internally and externally (published articles and books)	**Yes,** academia and scientific communities, government and other sectors
Department of Environment and Natural Resources (DENR)	Technical, conservation, research, policy advise, some research	**ES and poverty**	Provision of technical assistance, some knowledge generation	National and country's regions, site-specific Both coastal and terrestrial	**Yes Natural, social and interdisciplinary**	**Low to medium** (aside from some technical personnel, this inst. occasionally, contracts out research	**Yes Natural, social and interdisciplinary**	**Low** (aside from some technical personnel, this insti occasionally, contracts out research, but many times do not consider such scientific inputs)	Commissioned research, reports, database	Internally, externally (published or co-authored reports	**Yes**. Government Other users, Academe

Philippine Council for Aquatic and Marine Research and Development (PCAMRD)	Research coordination and policy advise	**ES (occasionally on poverty)**	Policy inputs through the research it coordinates and co-implement	National, country's regions, site-specific	**Yes Natural, social and interdisciplinary**	**Medium to high** (aside from its technical personnel, this insti funds or contracts out research	**Yes Natural, social and interdisciplinary**	**Medium to high** (aside from its technical personnel, this insti funds or contracts out research	Database, own reports, published articles and books	Internally, externally (published or co-authored reports	**Yes**, academia and scientific communities, government and other sectors
Department of Agriculture – Bureau of Fisheries and Aquatic Resources (DA-BAR)	Mandated to ensure that agricultural research are coordinated and undertaken for maximum utility to agriculture	**ES and poverty**	Knowledge generation The Exective Order which established DA-BAR requires the Bureau to tap farmers, farmers' organizations and research institutions especially state colleges and universities (SCUs) in the conduct of research for use by the Department of Agriculture (DA) and its clientele	National, country's regions, site-specific	**Yes Natural, social and interdisciplinary**	**Medium to high** (aside from its technical personnel, this insti funds or contracts out research	**Yes Natural, social and interdisciplinary**	**Medium to high** (aside from its technical personnel, this insti funds or contracts out research	Database, own reports, published articles and books	Internally, externally (published or co-authored reports	**Yes,** academia and scientific communities, government and other sectors

ANNEX 6 – INSTITUTIONAL ANALYSIS: VIETNAM

Summary questions:

a) What are the key institutions that have capacity to do research on ES and poverty?

Key institutions that have capacity to do research on ES and poverty are IMER, MERC, VIFEP, CERED, CERE, NIO (Institute of Oceanography), MCD, VEPA but it seems that ESPA research experience in Vietnam is still limited. Thus, these organisations (including MCD) should further improve their skills and knowledge, in order to make them capable in relevant ESPA research at both theoretical and practical aspects as well as on-the-ground and policy levels. NADAREP should also develop its capacity on ES and poverty alleviation since it is involved in aquatic resources protection and exploitation. In addition, it is suggested that ESPA research could involve more academics in Vietnam (Hanoi National University or NhaTrang University) as potential partners because they are relevant to ESPA issues, especially conceptually and theoretically.

b) What are the key institutions with capacity to apply research to promote management of ES for poverty alleviation?

CERED, VIFEP, MCD and VEPA can apply research to promote management of ES for poverty alleviation, at the different levels (micro, meso and macro). However, these organizations need a strong support and coordination from different stakeholders. NIO, IMER, MERC could improve their capacity to apply their knowledge-based research to the management issues. VASI is a potential institution and in a good position to apply research since it is devoted to coastal and marine resources management at the national level.

c) What are the main capacity needs in terms of:

1) Research

- Improve technical research skills (quantity and quality)
- More updated and accurate information
- Financial and human resources are strongly needed

2) Practice on linking ES and poverty?

- A stronger integration of natural and social sciences background, multidisciplinary research team.
- More investment in practical and critical analysis on ES and poverty (through case studies and primary research etc)
- More quantitative assessment on economic valuation of ES in Vietnam at the national level
- National updated database and information system of ES and poverty in Vietnam

d) What kind of strategies or actions are needed to strengthen capacity?

- Integrate relevant ESPA research issues into the program implementation by the government
- Improve research facilities (e.g. database and information)
- Create a research network and collaborators on ESPA between countries
- Employ technical international experts to improve research in ESPA-related issues

Table 1: Key institutions in ES and poverty alleviation in Vietnam

1. Organisation / institution	2. Responsibilities / mandate	3. Main area	4. Power	5. Scale	Institutional capacities to generate and use scientific						
					6. Involved in generating scientific knowledge? Natural, social, interdisciplinary?	*7. What capacity does it have to generate this knowledge?*	*8. Does it use scientific knowledge? Natural, social, interdisciplinary*	*9. What capacity does it have to interpret and apply knowledge?*	*10. Which sources of knowledge does it have access to?*	*11. Where is this knowledge located?*	*12. Can other inst gain access to the knowledge posse the institution?*
1. Vietnam Administration of Seas and Islands (VASI) – Minitry of Natural Resources and Environment - MONRE	Newly established. State management and governance of coasts, seas and islands (resources and environment)	ES and poverty	Administra tionsurvey s, policy, control, enforceme nt,	In coastal, marine areas and islands over country	Yes, Interdisciplinary. VASI is not a direct research organization, but they are supporting research institutions on the marine and coastal resources.	Medium VASI consists of several affiliated research institutions on the marine and coastal resources management.	Yes, both natural and social scientific knowledge; interdisciplinary	MEDIUM. VASI provides technical inputs and advices/reports to the government and MONRE in the marine and coastal resources management.	commissioned research, external consultants, sharing and exchange	Externally (international) and internally (provincial partners)	Yes (MONRE)
2. Vietnam Institute of Fisheries and Economic Planning VIFEP – Ministry of Agriculture and Rural Development - MARD	fisheries planning, management model research, technical consultancy in related fisheries development issues	ES and poverty	policy planning	national, 3 regions	yes, Interdisciplinary, but more focuses on socio-economic aspects. It conducts research on the master planning of fisheries development, fisheries economics and management model, sustainable livelihoods, aquaculture, and fisheries policy research.	High. VIFEP has a good capacity to conduct both macro and micro research relevant to the fisheries economics and planning issues. It has experienced professionals and researchers who are good at the field research.	yes, interdisciplinary, it is institute that is best known for its economic research into fisheries development issues.	Medium	Internal technical experts, external collaborators	Internally and externally (regional)	Yes (MARD, prov partners)
3. NADAREP (National Department of Aquatic Resources Exploitation and Protection) - Ministry of Agriculture and Rural Development - MARD	National aquatic resources protection and development. Program on exploitation planning and management	ES and poverty	policy planning	National	yes, Interdisciplinary, NADAREP focuses on coastal and marine resources ecosystems and species research, governance and enforcement	Medium. NADAREP has a functional network in most coastal provinces for coordinating and monitoring marine and coastal resources protection and exploitation (e.g. illegal destructive fishing practices). However, this is still a challenge due to insufficient capacity, financial and human resources.	Natural and social science. It focuses on the fisheries resources protection and development (conservation of endangered species, protected areas) and legislation enforcement (e.g. Fisheries Law, Aquatic Resources Protection Degree etc).	Medium. It uses a monitoring system of the marine and coastal resources protection (no. of protected areas) and aquatic resources exploitation (No. of registered boats, No. of fishing gears etc) for reporting to government and MARD	Internal and commissioned research, external collaborators	Internally and externally (regional)	Yes (MARD, prov partners)
4. Vietnam Environmental Protection Agency (VEPA) - MONRE	state management and protection of the environment and natural resources, biodiversity conservation and environmental policy planning	ES	Policy planning	National	yes, more natural and management science. It does research on ecosystems assessment (including wetlands) and natural resources	Medium. VEPA has a good position and experience in NR management and policy research. It is	More natural science	Medium, it does use scientific knowledge and inputs for the natural resources management and	internal researchers and experts, collaborators	internally (local provincial partners (DORNE – Department	Yes, MONRE, NG Donors

					management and policy development.	financially supported by the government and international agencies (IUCN, Netherlands Embassy)		policy development supporting MONRE and government agencies in environmental legislations (Environmental Protection Law, Biodiversity Action Plan, Biodiversity Law, Wetlands Protection and Ramsar Convention)		of Natural Resources and Environmental) and externally (international)	
5. Mangrove Ecosystem Research Centre (MERC)	provide professional training in biology, ecology, biodiversity and management of coastal ecosystem, coastal management projects, technical advice for NGOs and partners on mangrove planning and aquaculture in coastal areas.	ES	scientific inputs for possible policy interventions (mangrove ecosystem management)	National	yes, both interdisciplinary. It carries out various studies on biodiversity, socio-economic and management of mangrove ecosystems and ES (ecosystem services) and recently conducted a climate change impacts on the mangrove research.	High. MERD is staffed by good professional research staff and has experience working with NGOs in Vietnam.	Both, interdisciplinary	Medium. Most of the research inputs are useful for other implementers (NGOs, community and government)	internal researchers, professional teachers, published scientific reports	internally (Vietnam coastal areas) and externally (international and regional)	Yes. Universities (Hanc National Universit Education Agro-F University CRES MONRE National Parks(Coastal Wetland A MAB/UNESCO
6. Centre for Environmental Research, Education and Development (CERED)	promote environmental research and development, conduct climate change research in the coastal and mountainous areas, technical consultations for government policy planners in environmental and sustainable development	ES and poverty	scientific inputs for policy development (environment and climate change)	National	Yes, Interdisciplinary. It undertakes research in the environment and climate change (including environment and social issues such as livelihood resilience and social vulnerability as impacts of climate change)	High. Good quality and professional research led by experienced researchers/associates. Collaboration in international research network (including University of East Angelia, UK, IPCC-Intergovernmental Panel on Climate Change)	Both interdisciplinary	Medium. Research technical consultations are useful to Government, NGOs, academics and donors.	national researchers and experts network, International fellows and collaborators (e.g. University of East Angelia, UK), published scientific reports	internally and externally (international and regional)	Yes. Vietnam Union of Science and Tech Association - VUS MONRE, academ NGOs, donors
7. MAB – Man and Biosphere Program – CERE (Center for Environmental Research and Education), Hanoi University of Education	Harmonizing between people and nature	ES and poverty	Executive Enforcement	6 biosphere reserves in Vietnam	Yes, Assessment of biodiversity values for designated biosphere reserve, environmental education, research and training. Recently conducted an economic valuation of mangrove ecosystem services.	Medium. Good research and educational skills. Coordinating of Biosphere Reserve Network in Vietnam (Can Gio, Cat Tien, Red River Delta, Cat Ba, Kien Giang and Western Nghe an).	Yes, Biosphere reserves as learning laboratories for sustainable development for testing sustainable development initiatives with varying mixes of environmental, social and economic sector components.	Medium. Research outcomes are useful to implementation of strategies (including Vietnam's strategy for sustainable development Agenda 21, Millennium Development Goals)	Scientific research and application	Internally and externally (international and region)	Yes UNESCO, Biosph Reserves in Vietn NGOs, donors
8. Institute of Marine Environment and Resources (IMER)	Responsible for multidiscipline studies on the marine environment (physio-geo chemical-biological cycle) and provide the solutions for conservation/management of marine resources	ES	Carry out field and laboratory studies Consultative services for central government	Coastal provinces and offshore islands	Yes	High. Good expertise on marine biology and marine resources and environmental assessment and research. Well-developed network of scientific collaborators and associates.	Mainly focusing on natural sciences. IMER is a well-known research agency for marine biology and resources assessment (coral reefs, seagrass, and lagoons ecosystems). Not yet much involved in the	Medium, Research provides good reports and useful inputs for monitoring and managing marine resources and species.	Field studies and research application by the government and community, NGOs.	Local and internationally through consultant works and publications	Yes

							social science but develop knowledge on the coastal community fishing culture.				
9. Institute of Oceanography	Studying on marine typical ecosystems and how to use them reasonably	ES	Academic	Provincial & National	Yes, scientific knowledge; Natural, social, interdisciplinary. It conducts marine biodiversity and resources assessment, underwater surveys and economic valuation of coral reefs and seagrass.	HIGH. A well-known institute for its professional expertise and knowledge on the marine ecosystems and marine biology. Good network of scientific collaborators.	YES, Natural scientific knowledge. The institution is the research agency and transfers studied technologies to appropriate partners (such as government, community).	HIGH Application of aquaculture models and aquatic resources conservation (coral reef restoration) and management.	International, national published & own reports	Internally and externally (Website:www.vnio.org.vn; IO library; National & International journals)	Yes
10. Centre for Marinelife Conservation and Community Development (MCD)	marine and coastal resources conservation, management and community development	ES and poverty	Executive Enforcement	In pilot coastal provinces (Northern and South Central regions)	Yes, Interdisciplinary. It carries out applied research on coastal and marine resources management and community development (e.g. sustainable livelihoods)	Medium MCD is a solely marine conservation NGO in Vietnam. It is staffed by a multidisciplinary (natural resources management, biology, fisheries, social science) professionals and develops a network of scientific collaborators (national and international experts)	BOTH, INTERDISCIPLINARY	HIGH Application of appropriative livelihoods, coastal resources management models by the community, governments and NGOs	commissioned research, external consultants, external collaborative organisations	internally (local government and community) and externally (region)	Yes
11. WWF	marine conservation, protected areas and sustainable fisheries management	ES and poverty	policy development and enforcement	In pilot coastal provinces (Southern region)	Yes, Interdisciplinary it carries out research on coastal and marine resources assessment, sustainable aquaculture, fisheries economics for policy development.	Medium WWF marine and coastal program is staffed by a small team of marine biology and capture fisheries backgrounds.	BOTH, INTERDISCIPLINARY. It uses natural and social science for the fisheries management and capacity building.	MEDIUM Applications by local communities, government and NGOs (MSC certification for fisheries products in Ca Mau province)	own reports, external expert and collaborators	Internally and externally (region and international)	Yes
12. IUCN	coastal and wetlands management, education and policy development	ES and poverty	policy development and enforcement	in the wetlands (Mekong delta)	Yes, Interdisciplinary. It has a coastal and marine conservation program on the marine protected area (MPA), coastal management and policy development	Medium IUCN coastal and marine program has experience in Hon Mun MPA project.	BOTH, INTERDISCIPLINARY It uses natural and social science for capacity building and technical consultations on the coastal management.	MEDIUM Applications by the government (MARD) in policy/guidelines of MPA development	own reports, external expert and collaborators	externally (region and international)	Yes
13. Oxfam Great Britain	improve access of the poor to the basic needs (health, education and livelihoods), advocacy on public policy, and response to the climate change	Poverty	policy development,	in the poor provinces (including Central coastal region and	Yes, Interdisciplinary Oxfam is well-known for a number of action and policy research on participation, poverty, gender and human	High. Good research skills and capacity (internal and external), mobilization of	BOTH, INTERDISCIPLINARY, but more social science. It has recently developed a climate change program to address the	High. The research outputs are applicable for policy makers and advocacy for possible	own reports, external national and international experts	internally (local partners) and externally (international,	Yes

				Mekong delta)	rights, governance, livelihoods and climate change impacts	multidiscipline research team (national and international experts) and collaborating network with academics (e.g. Can Tho University, Kyoto University).	environmental and other associated livelihoods issues.	change in the policy and practice.		regional)	
14. World Bank	Focuses on achievement of the Millennium Development Goals that call for the elimination of poverty and sustained development	Poverty	Donor, International Development Association	National wide e.g. Vietnam's Coastal Wetlands Protection and Development Project	Yes, Interdisciplinary World Bank is well-known for country poverty assessment, and environmental monitoring. It conducts thematic research such as urbanization, water resources, education, health, infrastructure, credit, governance, policy, gender, wetlands resources management)	High High technical skills on poverty, socio-economic and political research. Good network of professional national and international experts/consultants.	Both, Interdisciplinary It uses multidisciplinary approach, and recently develops a strategy for climate change adaptation in Vietnam.	High Poverty reduction research are useful application by government, policy makers, NGOs, and academics	own reports, external consultants	Externally; Website: www.worldbank.org/vn Public Information Centers at different cities in Vietnam	Yes; Government, International Organizations, Academic, other international donc
15. DANIDA	Support programs focus on strengthening capture fisheries management, sustainable development aquaculture, sustainable livelihoods in and around marine protected areas (MPA)	Poverty	Donor, international development	selected coastal provinces in 3 regions	Yes, Interdisciplinary. DANIDA focuses on aquaculture, fisheries management and provides capacity building program for fisheries sector in Vietnam.	Medium Good technical skills on fisheries planning and capacity building	Both, Interdisciplinary	Medium Aquaculture extension by the local partners in the selected province. Fisheries management application by the government.	commissioned and external consultants	Internally (MARD) and externally (region, international)	Yes, Government (MARD), NGOs a Research Institut (RIA 1, RIA 3 etc) international donc