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Analysis of Coastal and Marine Resources:
A Contribution to the Philippine Country Environmental Analysis

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[1] World Bank Consultant. The findings, interpretations, and conclusions expressed herein are those of the author, and do not necessarily reflect the views of the World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent. The comments of Dr. John Dixon, Dr. Jan Bojo and Dr. Edgardo Gomez are gratefully acknowledged subject to the usual caveat. Rex Labao provided valuable research assistance. This report is for public use and comment. You may send your comments to the author at joepad@pldtdsl.net.

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I
INTRODUCTION

1.1 Background

Good environmental management is inextricably linked with sustainable development and growth. The Philippine Medium Term Development Plan notes that underutilization and mismanagement of the country's abundant natural resources is a major cause of poverty, particularly in the countryside. Similarly, the World Banks' Country Assistance Strategy notes that "environmental degradation is a significant contributor to poverty, inequality, and loss of livelihood." Against this background, the World Bank has decided to undertake a Country Environmental Analysis (CEA) for the Philippines. The CEA reviews and places a substantial volume of studies in a coherent framework, applies economic valuation across issues and interventions to enhance the rigor in prioritization, and thereby guides future programs and projects. The CEA is not only a document, but also a process of engagement and harmonization with various stakeholders, including the government, other development partners, NGOs, academics, and the private sector.

The CEA builds on past experience and:

(i) assesses environmental quality focusing on how this impacts human welfare and sustainability;
(ii) measures and analyzes the bio-physical significance and monetary cost of environmental degradation, and derive priority areas of action linked to poverty reduction and growth;
(iii) assesses the Government of Philippines', and other major stakeholders' capacity to manage the environmental challenges identified; and
(iv) identifies opportunities for reform and interventions.

1.2 Objectives

Building on the overall objectives of the CEA, the specific objectives of this sector study are to: (i) quantify the current benefits from coastal and marine resources (CMR), (ii) estimate the costs of environmental degradation of those resources, (iii) analyze the costs and benefits of major possible interventions to protect the resources and (iv) assess distributional impacts of environmental costs, as well as interventions, focusing on the burden to low-income groups, children, women and across geographic areas.

1.3 Methodology for the Estimation of Benefits and Damages

The Philippine endowment of CMR is summarized by ecosystem or biome in **Table 1.1**. The Philippines is considered the center of the center of marine shore fish biodiversity in the world in terms of number of species per unit area (Carpenter and Springer 2005). The larger center is the area called the Coral Triangle that includes Indonesia, parts of Malaysia and some Pacific countries such as Papua New Guinea, Timor Leste and Solomon Islands. This attribute of the Coral Triangle is getting heightened attention for global marine conservation and its contribution to local and regional economies. This is also triggered by the threats to marine biodiversity, particularly in the Philippines which is considered as the most highly threatened center of endemism (Roberts et al 2002).

Table 1.1 Philippine coastal and marine ecosystems

Total territorial water area (including EEZ)	2,200,200 km^2
Coastal	266,000 km^2
Shelf area (up to 200 m depth)	184,600 km^2
Coral reef (within 10-20 fathoms)	27,000 km^2
Mangroves	1,397 km^2
Seagrass / algal beds*	978 km^2
Other coastal	52,025 km^2
Oceanic	1,934,000 km^2
Coastline (length)	17,460 km

Sources: Philippine Fisheries Statistics (2006); Fortes (1995) for the seagrass area
*Fortes provided the author with a more recent though preliminary estimate of seagrass bed area of 27,282 km^2.

1.3.1 Types of CMR

This study focuses on naturally-occurring, living and renewable CMR classified into: (i) fish stocks; (ii) coral reefs; (iii) mangroves; (iv) seagrass / algal beds. Economic activities in the coastal zone that are a function of the biophysical status of these CMR, such as mariculture[2] and ecotourism, are considered as services provided by these resources. Other economic sectors such as shipping, oil and gas, and coastal settlements and industry that are generally independent of the biophysical status of CMR are not covered in this study.

Fish Stocks

Fish stocks refer to all finfish that thrive in wild state or habitat, which are taken primarily for human consumption, with or without the use of fishing vessels. This is based from the definition of *fishing* and *fish and fishery/aquatic products* (subset thereof) in Republic Act 8550[3]. A total of 2,818 marine fish species are found in the Philippines, majority of which are reef-associated at 1,727 fish species. Aliño and Tiquio (2008) indicated that fisheries associated with specific coastal ecosystems in the Philippines are broken down as follows: coral reefs – 307 genera; mangroves – 30 genera; seagrasses – 19 species. These numbers are considered underestimates since fauna in most locations are not yet fully described. Philippine marine fish landings are reported by species groups, which may be classified into pelagic and demersal. Pelagic species dwell on the upper level of the water column and cover wide areas throughout their life cycle while demersal species are bottom-dwellers.

Philippine capture fisheries is classified into municipal (or small-scale) and commercial. Municipal fishing is undertaken within municipal waters using fishing vessels of three (3) gross tons or less, or fishing not requiring the use of fishing vessels. Municipal waters refer to tidal waters within the municipality (which are not included within protected areas or fishery reserves) and marine waters within 15 kilometers from the coastline. Commercial fishing involves the use of passive or active gear for trade, business or profit beyond subsistence or sports fishing. It is further classified into: a) small scale – fishing with vessels of 3.1 gross tons (GT) up to 20 GT; b) medium scale – fishing

[2] Aquaculture in brackishwater ponds converted from mangroves is not an economic activity in this context as it involves the conversion and loss of mangrove forests.
[3] These definitions are based from Section 4 of Republic Act (RA) 8550 – An Act Providing for the Development, Management and Conservation of the Fisheries and Aquatic Resources Integrating all Laws Pertinent thereto, and for other Purposes. This section also draws from Castro and Huber (1997).

utilizing vessels of 20.1 GT up to 150 GT; c) large scale – fishing utilizing vessels of more than 150 GT.

Coral Reefs

Coral reefs are natural aggregation of coral skeleton, with or without living coral polyps, occurring in intertidal and subtidal marine waters. These constitute the largest biogenic structures on the planet and support assemblages of living corals and many other organisms, including fish, mollusks, marine worms, crustaceans, algae and sponges. Scientists have identified 915 reef fish species and more than 400 scleractinian coral species, 12 of which are endemic (Licuanan and Gomez 2000). There are over 488 species of stony corals in the Philippines out of 700 species documented globally. Recent analysis by Carpenter and Springer (2005) of the distribution data for close to 3000 species shows that global marine biodiversity has its peak in central Philippine islands, indicating that the country is the center of the center of marine shore fish biodiversity. Over time, various studies have reported different figures of total coral reef area in the Philippines. McAllister (1988) mentioned 44,000 km^2 with the most productive part of the coral reefs found in shallower than 20 fathoms or 37 meters and covers 33,000 km^2 (Carpenter 1977). More recent reports cite 25,060 km^2 (Tun et al 2004; Saito and Aliño 2008). On the other hand, the government-published Philippine Fisheries Profile indicates 27,000 km^2. A more recent estimate based on satellite images was provided by the UP Marine Science Institute (Appendix Table 1). The total, placed at over 10,000 km^2 excludes deep water reefs and slopes that cannot be discerned from the images and the reef areas in the disputed islands in the South China Sea. For the analysis that follows in this paper, the areas used are explained.

Mangrove Forests

Mangroves are communities of intertidal plants including all species of trees, shrubs, vines and herbs found on coasts, swamps or border of swamps. The Philippines has one of the richest diversity of coastal plants in the world (Calumpong and Menez 1996). The estimates of plant species vary. One study placed the number at approximately 60 to 70 mangrove and associated mangrove species from twenty-six families are found in the Philippines (King *et al* n.d.) while a brochure[4] on mangroves indicated 97 species. With respect to fish species, Philippine mangroves host one of the highest numbers in the world at 128 species (Chong *et al* 1990). The extent of mangrove cover in the Philippines over time is shown in Appendix Table 2. The time series data is updated with more recent information from the DENR-CMMO (Coastal and Marine Management Office) that is based from interpretation of satellite pictures from the National Mapping and Resource Information Authority (NAMRIA), which placed mangrove cover at 2,488 km^2 (Appendix Table 3). To date, the CMMO has validated on the ground 2,091 km^2 of mangrove area, which figure is used in the subsequent analysis. The increase in area has been attributed to the initiatives of various sectors including communities, NGOs and government agencies in mangrove rehabilitation and replanting.

Seagrass/Algal Beds

Sea grass beds are areas of salt-tolerant plants that occur in shallow near-shore waters, estuaries, lagoons, and adjacent to coral reefs. Seagrass are not true grass but are flowering plants that need sunshine thus thrive in shallower parts of the coast. Of the 27 species of seagrass found in Asia and 58 species globally, 19[5] are in the Philippines, the second most diverse next to Australia. They

[4] One Million Mangroves Cebu (www.coast.ph)
[5] http://www.wwf.org.ph/downloads/Biota/May2006.pdf

provide an array of environmental services; seagrass beds hold sediment in place and stabilize coasts, filter sewage, support a rich detrital community, and provide food and habitat for many important near-shore species. The Philippines has an approximate area 978 km^2 based on a survey of 96 sites (Fortes 1995). A more recent data provided by Fortes (personal communications) showed a total area of over 27,282 km^2 with the distribution by region shown in Appendix Table 4.

Other Coastal Ecosystems

Table 1.1 also lists "other" coastal and continental shelf. The latter is verified to be part of the coastal waters. "Other" coastal areas refer to the area that is not part of the categories indicated and is computed as the difference between the total for coastal and the sum of the areas for mangrove forests, seagrass beds, coral reefs and continental shelf. This area will be used when computing the unit productivities of each ecosystem.

1.3.2 Services and Benefits

The services provided by coastal and marine ecosystems in the Philippines are associated with the high level of biodiversity. They provide numerous benefits which directly affect people. The services and benefits will follow the classification in the Millennium Ecosystem Assessment (MA 2001):

- Provisioning services include the products obtained from ecosystems such as food and fiber, fuel, biochemicals, genetic resources, among others.
- Regulating services are benefits obtained from the regulation of ecosystem processes such as climate regulation, disease regulation, water purification and pollination.
- Cultural services constitute nonmaterial benefits such as spiritual and religious, recreation and ecotourism, aesthetic, inspiration, education, sense of place and cultural heritage.
- Supporting services are those that are necessary for the production of all other ecosystem services such as soil formation, nutrient cycling and primary production.

The foregoing categories cover the entire range of ecosystem services that are applicable to CMR. The specific benefits estimated in this study are listed by ecosystem in **Figure 1.1**. These are further described in Chapter II.

Figure 1.1 Categories of ecosystem services and benefits estimated in this study

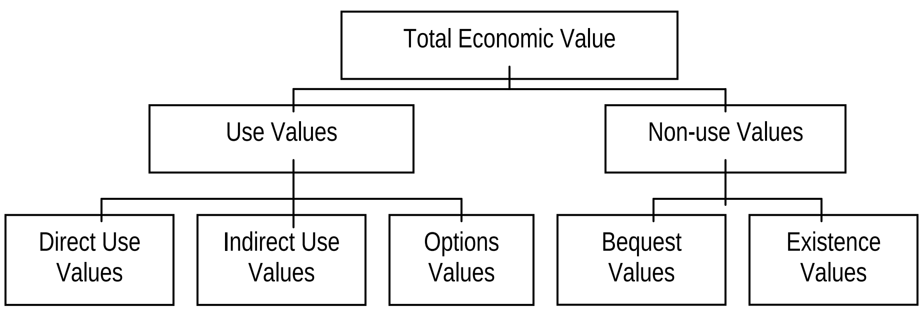
Ecosystem/ Resources	Provisioning	Cultural	Regulating	Supporting
Mangroves	• fisheries • forest products (e.g., timber, fuelwood)	• ecotourism • education and research	• carbon sequestration • coastal protection • waste assimilation	
Seagrass	• fisheries	• education and research	• coastal protection • waste assimilation	
Coral reefs	• fisheries	• ecotourism • education and research • existence value	• coastal protection	
Coastal	• fisheries	• ecotourism • education and research • existence value of certain species	• waste assimilation	• Mariculture, excluding brackishwater aquaculture
Oceanic	• fisheries	• education and research	• waste assimilation	

Total Economic Value

The classification and categories of ecosystem services and benefits lends itself to the concept of total economic value (TEV). The TEV of CMR consists of direct use values, indirect use values and option values (**Figure 1.2**). Direct use values include fishing and the gathering of mangrove forest products. Indirect use values are benefits derived from ecosystem functions such as coastal protection and waste assimilation. Option values capture the approximate value of a society's willingness-to-pay to safeguard an asset for the option of using it at a future date. Non-use values are usually divided between bequest and existence or `passive' use value (Arrow *et al* 1993). The former measures the benefit accruing to any individual from the knowledge that others might benefit from a resource in the future. The latter is unrelated to current use or option values, deriving from the existence of charismatic coastal and marine species and ecosystems. Values are measured net of all costs.

A large number of studies have been undertaken to estimate the TEV of CMR in specific locations in the country and elsewhere. The results from local studies are referred to and formed the basis for valuation in this paper. The valuation of benefits in this study refers to net benefits. It is emphasized though that in the absence of "consistent" sources of estimates of costs, particularly for fisheries and mariculture some simplifying assumptions are made, which could be revised when empirical studies become available. For ecotourism and benefits these are mostly net benefits from various surveys.

Figure 1.2 Components of Total Economic Value



1.3.3 Classification of Stressors on CMR

The typology of stressors on the coastal and marine environment in the recent UNEP report[6] *In Dead Water* (Nellemann *et al* 2008) provides a useful starting point in the estimation and attribution of environmental damages. The stressors described below may, separately or in mutually reinforcing manner, result in severe impacts on the CMR and the goods and services they provide. An expanded description of the pressures on the coastal and marine environment in the Philippines is in Appendix Table 5.

Unsustainable Fishing and Extraction

Fishery resources are renewable where the rate of regeneration depends on the fish biomass, status of coastal and marine habitats and other environmental factors. Unsustainable or overfishing occurs when the exploitation rate exceeds the rate of regeneration leading to "mining" of the fish stock. In

[6] This report provides most of the information in this section.

an open-access fishery where there are no effective mechanisms to regulate entry, the situation usually gravitates to both biological and economic overfishing. The latter occurs when the rents from the fishery are dissipated by overcapitalization. Most fisheries around the world are already biologically and economically overfished. The Philippines is in the same situation as will be discussed in the next chapter.

Marine Pollution and Coastal Development

The UNEP report describe marine pollution to include a range of threats from land-based and other sources such as oil spills, untreated sewage among others. There is a limit on the level of pollutants that the coastal and marine environment could absorb before these could have negative impacts on the living and non-living resources and on humans. Coastal development involves the conversion of coastal areas such as mangroves, beaches and foreshore areas into aquaculture ponds, human settlements and industrial development and for physical infrastructure such as roads, ports and the like. These have resulted into the total loss and/or fragmentation of coastal habitats that limit their ability to provide ecological services valuable to other economic sectors. The extent of reclamation and specific locations in the Philippines is presented in this study.

Climate Change

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) has indicated that oceans and coasts are vulnerable to climate change impacts such as rising surface water temperatures, sea level rise, changes in the wave climate, circulation, ice cover, fresh water run-off, salinity, oxygen levels and water acidity. Already, changes associated with climate change have been observed in algal, plankton and fish abundance in high latitude oceans. Coral bleaching recorded in many parts of the world has been blamed on high sea-surface temperature from climate change. AR4 predicted with recent risk analysis that between 24% and 30% of reefs in Asia are projected to be lost during the next 2 to 10 years and 10 to 30 years, respectively unless the stresses are removed and relatively large areas are protected. In the Philippines, a significant decrease of up to 46% of live coral cover in some sites was observed after the 1997-98 bleaching event with the northwestern part being most susceptible to elevated sea temperatures (Arceo *et al* 2001). Sea level rise puts at risk significant coastal activities (particularly aquaculture) and infrastructure in the country considering that about 62% of Philippine population has settled in coastal areas.

Exotic and Invasive Species Infestations

Scientists and policymakers have identified exotic and invasive species as one of the major threats to the marine environment through their impacts on biodiversity, biological productivity, habitat structure and fisheries. Globally, the number and severity of outbreaks and infestations of invasive species that have been deliberately or accidentally introduced is growing at an alarming rate (Ruiz et al 1997). For marine ecosystems, the database of Global Marine Invasive Species Threats[7] indicate 4 harmful marine invasive species affecting Palawan/North Borneo and Eastern Philippine seas which disrupt multiple species with wider ecosystem impacts. These consist of 2 species of algae and another 2 species of invertebrates. However, a global map[8] showing major pathways and origins of invasive or exotic species infestations in the marine environment indicates an apparent higher number of invasive species of less than 150. The pathways closely follow the major shipping routes.

[7] http://www.nature.org/marineinvasions

[8] http://maps.grida.no/go/graphic/major-pathways-and-origins-of-invasive-species-infestations-in-the-marine-environment

1.3.4 Estimating the Costs of Environmental Degradation

The valuation of damages will depend on the type of stressor. For unsustainable fishing, the damage is the cost of depletion. For coastal development resulting in the loss of coastal and marine habitats, the cost of damages is represented by foregone benefits, which are those mentioned in **Figure 1.1**. The impacts of pollution are measured by the reduction in the provision of goods and services such as fisheries, mangrove forest products and by the cost of human morbidity and mortality from exposure to polluted coastal and marine waters. The impacts of climate change such as coral bleaching is measured by the reduction in fisheries and ecotourism. These are discussed in the earlier section and further in Chapter III.

1.3.5 Distributional Analysis

Who bears the benefits from and costs of environmental damages to CMR are two important considerations that this study addresses. A key consideration is the municipal fisheries sector where poverty is more prevalent compared to the commercial fisheries sector. Poverty, however, is also a major issue among the commercial fishing crew. Women and children are also involved in fishing operations but primarily in the municipal sector through gleaning and upkeep of fishing equipment and paraphernalia. The capacity of the poor to participate in appropriate interventions to address the environmental damages is looked into in the context of poverty alleviation.

1.3.6 Sources of Data and Limitations of the Study

Data for the implementation of the above framework are primarily sourced from secondary sources. The quality and accuracy of the estimates of the benefits and costs in this study primarily depends on the available secondary data. Effort was exerted to verify the accuracy of secondary data, where possible. The attribution of benefits and damages across ecosystems has proven to be quite daunting due to scarce information, hence, in some occasions, the author relied on familiarity with the sector and personal communications with other experts. The important assumptions made are explicitly indicated in the report, where appropriate, for clarity and verification. To complement the secondary information, primary data was collected to obtain better assessment of the costs and benefits of marine protected areas, particularly a community-initiated and maintained MPA. The Apo Island Marine Sanctuary in Negros Oriental was visited and the results are incorporated in this report.

The estimates of benefits and damages are for 2006, which is the most recent year where data necessary for the study are reasonably complete. The analysis provides a snapshot about the industry although trends have been described using past studies in the sector.

II

ECONOMIC VALUE OF COASTAL AND MARINE RESOURCES

2.1 Ecosystem Goods and Services

2.1.1 Provisioning Services

Provisioning services are the products obtained from coastal and marine ecosystem, including primarily (i) food, (ii) fuelwood, (iii) biochemicals, natural medicines and pharmaceuticals, and (iv) ornamental resources particularly marine aquarium fishes.

Fish Production from Coastal and Oceanic Waters

In 1980, Philippine fishery wealth was assessed, using the Delphi technique, by a panel of experts from various national and international agencies, the results of which are presented in **Table 2.**1. These estimates of maximum sustainable yield (MSY) for conventional fishery resources have been reflected in national fisheries policies (BFAR 1995 as cited in Barut et al 1997).

Table 2.1 Estimated potential annual production from Philippine marine waters

Area	Potential Production (metric tons)		
	Pelagic	Demersal	Total
I. Coastal areas (up to 200 m isobath)	800,000 +/- 200,000	600,000 +/- 200,000	1,400,000 +/- 200,000
Region 1: Tayabas Sea; Camotes Sea; Visayan Sea; Sibuyan Sea; Ragay Gulf; Samar Seal; related bays	120,000 +/-30,000	90,000 +/- 30,000	210,000 +/- 30,000
Region 2: South Sulu Sea; East Sulu Sea; Bohol Sea; Guimaras Strait; related bays	112,000 +/- 30,000	84,000 +/- 30,000	196,000 +/- 30,000
Region 3: Moro Gulf; Davao Gulf, Southeast Mindanao Coast	80,000 +/- 20,000	60,000 +/- 20,000	140,000 +/- 20,000
Region 4: Est Sulu Sea, Palawan, Mindoro (West Palawan; Cuyo Pass; West Sulu Sea; Batangas Coast)	264,000 +/- 70,000	198 ,000+/- 70,000	462,000 +/- 70,000
Region 5: North and Northwest Luzon (Lingayen Gulf; Manila Bay; Babuyan Channel; Palawan Bay)	64,000 +/- 30,000	48,000 +/- 20,000	112,000 +/- 30,000
Region 6: Pacific Coast except Southeast Mindanao (Leyte Gulf; Lagonoy Gulf; Lamon Bay; Casiguran Sound)	160,000 +/- 30,000	120,000 +/- 40,000	280,000 +/- 40,000
II. Oceanic areas	250,000 +/- 50,000	0	250,000 +/- 50,000
Total			1,650,000 +/- 200,000

Sources: NRMC/FIDC (1980); also cited in Pauly (1986)

Subsequent assessments of Philippine demersal and pelagic fisheries are close to the above estimates of experts. For demersal fisheries, the estimated MSY for exploited resources is placed at 340,000 – 390,000 mt (Silvestre and Pauly 1987). Including the MSY estimate for unexploited and lightly fished hard bottom areas[9] of 200,000 mt would bring the total to 540,000-590,000 mt (Barut *et al* 1997). For exploited pelagic fisheries, MSY estimate is placed at 550,000 mt (Dalzell *et al* 1987) and when combined with MSY estimates of 250,000 mt for lightly fished small pelagic resources or fishing grounds[10], this would approximate the experts' estimates (Barut *et al* 1997). However, the

[9] Offshore hard bottom areas around Palawan, southern Sulu Sea and central part of the country's Pacific coast.
[10] Waters off Palawan, parts of the country's Pacific coast and some parts of Mindanao.

rates of exploitation is beyond the MSY level as shown by the above studies of Silvestre and Pauly (1987), Dalzell *et al* (1987) and by resource accounting studies of Padilla and de Guzman (1994) and NSCB (1999). These studies have confirmed considerable depletion and depreciation of fishery resources at time of preparation of the reports.

In the context of the biological surplus yield model that these studies used, the current level of production occurs at a higher level of effort indicating overcapitalization that is typical of a common property regime of exploitation in Philippine fisheries. At the industry level, the potential rents from the fisheries have been fully dissipated by the high average fishing costs. In the long-run, inefficient fishing vessels are expected to be driven out as the industry moves to a point of bio-economic equilibrium where revenues cover total costs. Nevertheless some rents are realized by certain sectors due to better efficiency of fishing operations and higher remaining fish stocks. For this report, these intra-marginal rents or net values are estimated at 10% of gross values for all fisheries. This seems very reasonable.

Production data obtained from the Bureau of Fisheries and Aquatic Resources (BFAR) and the Bureau of Agricultural Statistics (BAS) are only for the top 30 fish families. Additional data was requested from BAS in order to disaggregate the production and value data and derive breakdown by species grouping and attribution by ecosystem. The attribution by ecosystem was based from information contained in Fishbase (www.fishbase.org) and through consultations with some experts from the University of the Philippines Marine Science Institute (UPMSI). The production from "resident" species within each ecosystem are attributed fully to that ecosystem while for "transient" species, a conservative 10% attribution was made. The listing of species groups and the ecosystems these utilize in their lifecycle is in Appendix Table 6.

Table 2.2 Fisheries production, 2006 (metric tons)

Species group	Ecosystem						
	Coastal					Oceanic	Total
	Mangrove	Seagrass	Coral reef	Other coastal	Sub-total		
Small pelagic	10,100	-	83,272	950,743	1,044,115	-	1,044,115
Large pelagic	178	-	1,355	-	1,532	603,372	604,904
Demersal	12,991	3,089	34,272	299,097	349,448	-	349,448
Other fish	-	-	-	9,883	9,883	-	9,883
Sub-total	23,269	3,089	118,898	1,259,723	1,404,978	603,372	2,008,350
% to row total	1.16	0.15	5.92	62.72	69.96	30.04	100.00
Invertebrates	6,833	5,292	75,851	52,805	140,781	-	140,781
Mammals	-	-	536	4,822	5,357	-	5,357
Aquatic plants	-	29	285	-	314	-	314
Sub-total	6,833	5,320	76,672	57,626	146,452	-	146,452
Total	30,102	8,410	195,570	1,317,349	1,551,430	603,372	2,154,802
% to row total	1.40	0.39	9.08	61.14	72.00	28.00	100.00

Actual capture fisheries production in 2006 is presented in **Table 2.2** while the time series data (2002-2006) by volume and value are in Appendix Tables 7a and 7b. Total fisheries production in 2006 reached over 2,154,000 mt, up from 1,750,000 mt in 2002. This represented an average annual increase of over 5% during this period. Over half of the total fish catch was accounted for by small pelagic species, followed by large pelagic and demersal species. Non-fish catches in 2006 exceeded

146,000 mt, accounted primarily by invertebrates. By ecosystem, the biggest share is from nearshore areas (other coastal), excluding mangrove forests, seagrass beds and coral reefs.

For the comparisons, it is assumed that oceanic pelagics are primarily large pelagic species and coastal pelagics are small pelagic species. Actual production of demersal species of about 350,000 mt is just half the potential of 600,000 +/-100,000 mt. Large pelagics catches of about 605,000 mt is more than twice the annual potential yield of a 250,000+/-50,000 mt. The production from small pelagics at about 1,044,000 mt is about 15% higher than the annual potential yield of 800,000+/-100,000 mt. Total fisheries production of over 2 million mt is close to the maximum potential yield of 1,900,000 mt.

Table 2.3 Estimated market value of potential production, Philippines

	Average price in 2006 (PhP/mt)	Potential annual production (mt/yr)	Total gross value in 2006 (million PhP)	Net value in 2006 (million PhP)
I. Coastal (small pelagic species)				
Low Estimate	55,574	600,000	33,344	3,334.42
High Estimate		1,000,000	55,574	5,557.36
Average		800,000	44,459	4,445.89
II. Coastal (demersal species)				
Low Estimate	65,822	400,000	26,329	2,632.88
High Estimate		800,000	52,658	5,265.76
Average		600,000	39,493	3,949.32
III. Oceanic (large pelagics species only)				
Low Estimate	65,173	200,000	13,035	1,303.46
High Estimate		300,000	19,552	1,955.19
Average		250,000	16,293	1,629.33
Total				
Low Estimate		1,200,000	72,708	7,270.76
High Estimate		2,100,000	127,783	12,778.32
Average		1,650,000	100,245	10,024.54

Notes

Production from coastal areas (pelagics and demersal species) includes those associated with mangroves, seagrass and coral reefs. Attribution of production to these ecosystems will be made in succeeding sections. Prices are computed from the Philippine Fisheries Statistics.

Net value refers to the economic rents from fishing assumed to be 10% of the gross value (refer to discussions).

Using wholesale prices[11] in 2006, the gross value of potential production is shown in **Table 2.3**. This shows that the value of sustainable production from capture fisheries (excluding invertebrates and aquatic plants) could reach about PhP 128 billion per year. However, due to the open-access exploitation regime, the net value is placed at about PhP 13 billion. On the other hand, the value of actual fisheries production shown in **Table 2.4** is placed at over PhP 100 billion with the net value at 10%. A subset of the fisheries production data is the quantity and value of live ornamental fish that is collected primarily from coral reefs. This is a huge industry and accounts for much of the value of fisheries in this coral reef ecosystem. The total quantity reached a peak of almost 7,000 mt and

[11] All price data used in this report refer to wholesale prices, except otherwise stated.

tapered down to 6,660 mt in 2006 with total value of over PhP 371 million in the same year (**Table 2.5**).

Table 2.4 Gross and net value of fisheries production, 2006 (million PhP)

Species Group	Gross Value					
	Coastal				Oceanic	Total
	Mangroves	Seagrass	Coral Reef	Coastal		
Small Pelagics	248.2	-	2,947.9	37,114.5	-	40,310.6
Large Pelagics	12.4	-	77.7	-	31,769.0	31,859.0
Demersal	650.9	183.8	1,952.5	17,231.5	-	20,018.7
Other Fish	-	-	-	650.2	-	650.2
Sub-Total	911.4	183.8	4,978.2	54,996.1	31,769.0	92,838.5
% to row total	1.0	0.2	5.4	59.2	34.2	100.0
Invertebrates	520.0	380.5	4,566.0	3,775.7	-	9,242.2
Mammals	-	-	39.2	352.4	-	391.5
Aquatic Plants	-	2.1	21.3	-	-	23.5
Sub-Total	*520.0*	*382.7*	*4,626.4*	*4,128.1*	-	9,657.2
Total: All Species	**1,431.5**	**566.5**	**9,604.6**	**59,124.2**	**31,769.0**	**102,495.7**
% to row total	**1.4**	**0.6**	**9.4**	**57.7**	**31.0**	**100.0**
	Net Value					
Small Pelagics	24.8	-	294.8	3,711.5	-	4,031.1
Large Pelagics	1.2	-	7.8	-	3,176.9	3,185.9
Demersal	65.1	18.4	195.3	1,723.1	-	2,001.9
Other Fish	-	-	-	65.0	-	65.0
Sub-Total	91.1	18.4	497.8	5,499.6	3,176.9	9,283.8
Invertebrates	52.0	38.1	456.6	377.6	-	924.2
Mammals	-	-	3.9	35.2	-	39.2
Aquatic Plants	-	0.2	2.1	-	-	2.3
Sub-Total	52.0	38.3	462.6	412.8	-	965.7
Total: All Species	**143.1**	**56.7**	**960.5**	**5,912.4**	**3,176.9**	**10,249.6**

Table 2.5 Quantity and value of live ornamental fish exports, 2002-2006

Year	Quantity (mt)	FOB Value (million PhP)	Net value (million PhP)
2002	5,632	333.13	33.31
2003	5,912	348.17	34.82
2004	6,941	380.05	38.01
2005	6,698	368.91	36.89
2006	6,660	371.14	37.11

Source: BFAR (various years)

Net value/economic rent is assumed at 10% of the gross value.

Fish Production from Coral Reefs

The status of Philippine coral reefs from 1981 to 2004 is shown in **Table 2.6**. These were based from on-site monitoring of a number of coral reef sites in the Philippines conducted by local institutions, primarily academic institutions. Coral reefs in the Philippines have been continuously degraded over time which has reached alarming proportions. The proportion of poor coral cover has increased while areas with excellent coral cover has steadily declined from over 5% in 1981 to 4% in 1997 and less than 1% in 2000-2004. Relatively better reef cover may be found in Celebes Sea, Southern Philippine Sea, Sulu Sea and the Visayas biogeographic regions (Nañola *et al* 2005). For the purpose of this study, the national summary will be used as there are no available estimates of the total area of coral reefs by biogeographic region.

Table 2.6 Status of Philippine coral reefs (% of total area)

Location	Category			
	Poor (0-24.9%)	Fair (25-49.9%)	Good (50-74.9%)	Excellent (75-100%)
1981 (Gomez et al 1981)				
Luzon	31.4	42.8	22.3	3.5
Visayas	29.6	36.9	26.1	7.3
Mindanao	48.8	30.2	14	7
All	31.8	38.8	23.6	5.7
1997 (Licuanan and Gomez 2000)				
All	27	42	28	4
2000 - 2004 (Nanola et al 2005; Nanola et al 2006)				
South China Sea	46	54	0	0
Northern Philippine Sea	48.1	51.9	0	0
Southern Philippine Sea	31	60.2	8.8	0
Visayas Region	47.6	50	2.4	0
Sulu Sea	56	36	8	0
Celebes Sea	20.5	48.7	28.2	2.6
All	40.8	53.3	5.7	0.2

Percentages enclosed in parentheses after each category refer to live hard coral cover.

Using results from empirical studies (which are a subset of those listed in Appendix Tables 8 and 9), McAllister (1988) estimated the sustainable annual production per km^2 from coral reefs according to condition: excellent condition at 18 mt; good condition at 13 mt; fair condition at 8 mt; poor condition at 3 mt (Appendix Table 9). Using the figures from McAllister and the most recent information on coral reef condition and the area of coral reefs, the quantity and value of potential and actual fisheries yields from coral reefs are shown in **Table 2.7**. The annual potential yield from coral reef species, based from a coral reef area of 33,000 km^2 ranges from 351,000 to 429,000 mt. The estimated current yield using reef area of 27,000 km^2 is placed at over 169,000 mt. Potential net values stood at about PhP 2.0 to PhP 2.5 billion while actual net value stood at less than PhP 1 billion using the average price for coral reef associated species in 2006 of PhP 57 per kg. The estimated contribution of coral reefs to coastal and marine fisheries production in 2006 is slightly lower compared to the estimates using reef conditions in 2000-2004 in Table 2.7. This may be due to the continuing degradation of coral reef cover between 2000-2004 and 2006 resulting in further decline in coral reef productivity.

Table 2.7 Calculated potential production quantity and value from Philippine coral reefs, 2006 prices

Reef condition		Total reef area (km^2)		Sustainable production ($tons/km^2/yr$)	Potential yield if reefs are in "good" condition (mt/yr)	Present calculated yield using current area and reef conditions (mt/yr)
Condition	% Area	Maximum possible area	Current Area			
Poor	40.8	33,000	27,000	3	429,000	33,048
Fair	53.3			8	(using maximum area	115,128
Good	5.7			13	351,000	20,007
Excellent	0.2			18	(using current area)	972
Total	100					169,155
Gross value of potential production (PhP million/year)			(using maximum area)		24,449	9,640
			(using current area)		20,003	
Net value of potential production (PhP million/year)			(using maximum area)		2,445	964
			(using current area)		2,000	

Fish Production from Mangroves

The estimates of fish production from mangrove forests are based from local studies which are summarized in **Table 2.8** (refer also to Appendix Tables 10 to 13). Fisheries productivity[12] covers a wide range from 142 - 578 kg/ha/yr. It is site-dependent while the influence in the quality of mangrove stands is not definitive. The value of mangrove fisheries is estimated using the reported mangrove cover in 1918, in 1980 corresponding to the time of the estimation of potential fisheries yields in the FIDC/NRMC report, and in 2006. With the original mangrove cover of 5,000 km^2 (500,000 ha) in 1918, the gross value of potential production from mangrove fisheries would range from PhP 3.57 to 14.56 billion per year in 2006 prices. In 1980 with mangrove area reduced to an estimated 215,793 ha, potential production value is about PhP 1.54 – 6.28 billion/yr. The corresponding gross values in 2006 decreased to the range of PhP 1.49 - 6.09 billion/yr. Net values are 10% of the gross values. The estimated contribution of mangrove ecosystems to actual fisheries production in 2006 reached 23,269 mt. With the inclusion of invertebrates to fish production, the total contribution reached 30,102 mt (Table 2.2). This estimate is close to the 29,681 mt estimated potential production in the same year using the lower end of the range in **Table 2.8**.

Fish Production from Seagrass/Algal Beds

It is recognized that seagrass beds are habitats for numerous fish species and serve as food for sea turtles, hundreds of fish species, several species of waterfowl and the manatee and dugong (Short *et al* 2004). The endangered Dugong feed almost entirely on seagrasses (Spalding *et al* 2003). Seagrasses also support complex food webs on account of their physical structure and primary production. Seagrasses are important part of the detrital food chain, filter nutrients and contaminants from the water, stabilize sediments and dampen water currents. There is no study available to the author that provides an estimate of potential fisheries production from seagrass beds. Thus, the estimated contribution seagrass and algal beds to fisheries production is based primarily from the attribution of the fisheries catch to various coastal and marine ecosystems. For 2006, the contribution

[12] The higher figure from Walton *et al* is not considered at it assumed a very high dependence (at 80%) of coastal fisheries to mangrove ecosystems.

is placed at about 3,089 mt of finfishes and additional 8,410 mt of invertebrates and aquatic plants. The total value is estimated at PhP 379 million, about 29% accounted by finfishes.

Table 2.8 Comparative fisheries production, gross and net values from mangrove forests

Author	Schatz (1991)	PIDS (1997)	Janssen and Padilla (1999)	Walton et al (2005)
Reference year	1990	1992-1995	1995	2004
Location	Central Visayas	Pagbilao Bay and Ulugan Bay	Pagbilao Bay	Aklan
Type of vegetation	Managed and unmanaged mangroves	Old growth (Ulugan) and secondary growth (Pagbilao)	Secondary growth	Mangrove reforestation
Fisheries production (kg/ha/yr)	667	175.4	141.9	578 - 2568
Gross value (PhP/ha/yr) for reference year	13,450	6,743	1,940	25,307-121,072
Gross value (PhP/ha/yr) for 2006: Average price = 50.37/kg	33,597	8,835	7,149	29,114-129,350
Mangrove area in 1918 (ha)	500,000			
Fish production (mt)	70,969 - 289,000			
Gross value in 2006 (PhP million/year)	3,575 - 14,557			
Net value in 2006 (PhP million/year)	358 - 1,456			
Mangrove area in 1980 (ha)	215,793			
Fish production (mt)	30,629 - 124,728			
Gross value in 2006 (PhP million/year)	1,543 - 6,283			
Net value in 2006 (PhP million/year)	154 - 628			
Mangrove area in 2006 (ha)	209,109			
Fish production (mt)	29,681 - 120,865			
Gross value in 2006 (PhP million/year)	1,495 - 6,088			
Net value in 2006 (PhP million/year)	150 - 609			

Notes: Upper bound value of production per year is the lower bound from the Walton et al (2005) study.

Net values are estimated at 10% of the gross values.

Timber, Fuelwood and other Raw Materials

Timber production data from surveys and studies done in Philippine mangroves and reported in several reports are shown in **Table 2.9**. These are either determined from potential sustainable harvests or actual harvests based on the level of dependence of adjacent communities for various household purposes such as for house construction, fencing and fuelwood. The range of sustainable harvests is from 1.2 - 13.5 m^3/ha/yr. The volume of wood production from mangroves for the entire country may be estimated based from the various studies and using mangrove forest cover in 2006.

Table 2.9 Comparative "timber" production from mangrove forests and corresponding gross values

Author	Schatz (1991)			PIDS (1997)		Janssen and Padilla (1999)	Walton et al (2005)
Reference year	1990			1992-1995		1995	2004
Location	Central Visayas			Pagbilao Bay and Ulugan Bay[a]		Pagbilao Bay[b]	Aklan[c]
Type of Vegetation	Mangrove Plantation	Managed Naturally Regenerated Stands	Unmanaged Under-stocked Stands	Old Growth (Ulugan Bay)	Secondary Growth (Pagbilao Bay)	Secondary growth	Mangrove reforestation
Timber Production (m^3/ha/yr)	13	7.5	3.5	3.075	2.575	2.4	13.4
Net value[d] (PhP/ha/yr) for reference year	1,950	1,125	525	1,283	1,182	971	1,638
Average price in reference year	300	300	300	834	918	819	244
Average price in 2006 (PhP/kg)	908	908	908	1,836	2,021	1,540	265
Net value (PhP/ha/yr) for 2006	5,903	3,406	1,589	2,823	2,602	1,825	1,776
Philippine mangrove area (ha)	209,109	209,109	209,109	209,109	209,109	209,109	209,109
Total Net Value (PhP million/yr)	1,234	712	332	590	544	382	371

a - Timber production corresponds to degrees of dependence of households to the mangroves: 30%; 50%; 75%; 100%. Gross value is based on shadow prices of next best alternative to the mangrove timber products.

b - Timber production is based from subsistence forestry extraction. Gross value is based on shadow price of the next best alternative to the actual use of mangrove timber products.

c - Based from thinnings used apparently for fuelwood.

d - Values depend on uses of mangrove timber products such as fuelwood, house construction, fencing, etc. Net value is assumed 50% of gross value.

The valuation of non-marketed mangrove forest products depends on the purpose it is used for and shadow prices adjusted to 2006 equivalent were used. The higher gross value per unit volume for the mangrove forest in Pagbilao and in Ulugan Bay is due to use for house construction while the lower gross value in Aklan is due to fuelwood use. Production costs of alternative timber products are assumed at 50%, hence net values are half of gross values. Net value of timber production in 2006 ranged from a low of PhP 332 million to a high of PhP 1.23 billion. The average for all the estimates is about PhP 596 million for the entire Philippines in 2006.

2.1.2 Cultural Services

Cultural services are the nonmaterial benefits obtained from coastal and marine ecosystems that include the following: (i) recreation and ecotourism; (ii) formal and informal education; and (iii) aesthetics as reflected in land and housing values and preservation of scenic drives along coastal areas. Perhaps, the major cultural service associated with coastal and marine ecosystems is recreation and ecotourism through SCUBA diving, snorkeling, beach combing, sun bathing and sporting activities in coastal waters.

Recreation and Ecotourism

Ecological tourism is a form of sustainable tourism within a natural and cultural heritage area where community participation, protection and management of natural resources, culture and indigenous knowledge and practices, among others as well as economic benefits are fostered and pursued for the enrichment of host communities and satisfaction of visitors.[13] Ecotourism could therefore be a significant tool in sustainable development; it seeks to put in place mechanisms that are environmentally-sustainable, economically-viable, and socially-equitable in order to bring about development for the benefit of local communities, including the poor and marginalized sectors.

Coastal and marine-related ecotourism activities include the following: (i) wildlife watching or interaction; (ii) SCUBA diving and snorkeling; and (iii) beach visitation and swimming. From various websites and promotional materials, the major destinations are compiled. Estimates of the willingness-to-pay to enjoy these recreational activities in the major destinations are summarized from Philippine studies. Most of the studies have been on SCUBA diving while there is a sprinkle of studies on wildlife watching/interaction, beach visitation and the like. Visitation rates are obtained from the Protected Areas and Wildlife Bureau (DENR-PAWB) for sites that are part of the National Integrated Protected Areas System (NIPAS). For other sites, visitor arrivals by province maintained by the Department of Tourism were used. A number of simplifying assumptions were made to arrive at the estimate (Appendix Tables 14a to 14e). The estimates were adjusted to 2006 values following changes in GDP.

Table 2.10 Recreational benefits from coastal and marine-related activities, 2006

Type of Activity	Total Benefits (PhP million)	Percent
Coral Reefs		
Scuba diving	94.66	38.4
Other coastal-related activities		
Dolphin and whale watching	2.21	0.9
Swimming, snorkeling and beach visiting	123.37	50.0
Mangrove Ecotourism	26.55	10.8
Total	**246.78**	100.0

The summary of recreational benefits is shown in **Table 2.10**. The total recreational value in terms of the WTP is approximately PhP 246.8 million in 2006. The biggest is from swimming, snorkeling and beach visiting, reflecting the numerous beautiful beaches in the country. Although the number of SCUBA diving visits is relatively small, the WTP is quite high, due to high marine biodiversity in

[13] http://www.ecotourismphilippines.com/default2.php?TID1=2&TID2=1

preferred sites such as those in Batangas (Mabini-Tingloy, Puerto Galera, Apo Island and TRNP) and the relatively well-off enthusiasts. Mangrove ecotourism is growing and the potential is high if made accessible through organized tours and boardwalk facilities. Wildlife watching is a growing activity, particularly for dolphins in the Visayas and whale shark in Sorsogon.

Education and Research Values

The coastal and marine sector has been the focus of research by institutions in the academe, government and other sectors to generate information for better understanding and management of these resources. The description of the research projects of these institutions were requested over the period 2002-2006. The information included budget, ecosystems and resources covered and the duration. The project costs were attributed to various ecosystems based from the project components and distributed equally over the years of project duration (**Table 2.11**).

Table 2.11 Expenditures on research on coastal and marine resources by institution, 2002-2006 (in PhP)

Year	Ecosystem					
	Mangroves	Coral Reefs	Seagrasses	Other Coastal	Oceanic	Total
2002	0.03	0.01	0.01	0.01	0.01	0.05
2003	2.17	2.23	2.16	0.03	0.03	6.62
2004	2.14	5.83	2.14	0.93	0.93	11.98
2005	0.76	1.99	1.99	2.42	0.68	7.83
2006	0.63	2.21	0.63	2.21	0.63	6.33
Annual Average	1.15	2.45	1.39	1.12	0.46	6.56
Percentage	17.5	37.4	21.1	17.1	7.0	100.0

Note: Data is from organizations and insitutions that provided requested data as of 15 June 2008.

Existence Values

The Philippines has one of the most diverse marine ecosystems in the world which are habitats to a number of globally important and charismatic and currently endangered marine species such as the whale shark and marine turtles. Economic values may be derived not only from experiencing these natural wonders but also from knowledge of the continued existence of these marine species and ecosystems. Several studies have estimated their existence values and the results are summarized in **Table 2.12**. The survey-based studies were conducted in specific locations and the results show that the willingness to contribute to a conservation fund to ensure continued existence of the endangered species ranges from \$0.17 per household per month for marine turtles to \$0.34 per household per month for whale shark. For TRNP, the amount ranges from PhP 135-278 per household per year, according to support for the conservation fund and certainty of willingness to contribute to the fund. The estimates are scaled up to the population of the survey sites only and not at the national level due to the limited geographic scope of the surveys resulting in the uncertainty about the direction and robustness of the existence values when covering a wider area. The estimates of total existence values are listed below.

2.1.3 Regulating Services

The estimated benefits obtained from the regulation of ecosystem processes include: (i) climate regulation; (ii) erosion control and coastal protection provided by mangroves and coral reefs against storm surges; and (iii) waste assimilation.

Table 2.12. Existence values from species and ecosystems

Species	Whale shark	Marine turtle	Tubbataha Reefs National
Survey Coverage	Sorsogon	Davao	Quezon City, Cebu City and and Puerto Princesa
Year of Study	2005	2006	2002
Estimated Amount	US$ 0.34	US$ 0.17	PhP135-278
Estimated Amount (in Php)	18.73	9.37	PhP135-278
Unit of measure	per household per month	per household per month	per household per yr
Equivalent Amount in 2006 (in PhP)	19.25	9.37	162 - 334
Raising factor: Number of households in 2006 in survey sites*	142,809	274,313	742,207
Estimates for 2006 (million pesos/yr)	2.75	30.83	120.23 - 247.58
Author (year)	Indab (2007)	Indab (in progress)	Subade (2005)

*Based on the population in survey sites in 2006 and average household size of 4.97 in the same year.

Carbon Sequestration

Tropical forests, including mangroves, are carbon sinks. They regulate carbon dioxide in the global atmosphere through the process of respiration and photosynthesis where CO_2 is absorbed and stored in their biomass. As cited by Sheeran (2006), Villarin *et al* (1999) and Lasco and Pulhin (2000), the estimated carbon sequestration and storage for major forest and land use types in the Philippines, including mangroves is placed at 1.5 mt/ha/yr (**Table 2.13**). The total carbon sequestered by mangroves is equivalent to 0.31 million mt/ha/yr which has a value of PhP 172.2 million in 2006 using average price of CERs from primary CDM sources (i.e., new CERs) of US$10.7. The carbon sequestration value is PhP 823/ha/yr or US$16/ha/yr. The IPCC reviewed the costs of existing forest-based carbon mitigation projects and found that the costs range from $0.1 to $28 per ton of carbon. However, because these calculations typically exclude opportunity costs they underestimate the social costs of forestry options for mitigating climate change, which is quite considerable in the context of livelihoods and poverty reduction (Sheeran 2006).

Table 2.13 Carbon storage and sequestration from mangrove forests

Area (ha)	209,109
Carbon storage (tons/ha)	
tons/ha	87.5
million tons	18.30
Carbon sequestration	
tons/ha/yr	1.5
million tons/ha/yr	0.31
Value	
CER value fom primary CDM in 2006 (US$/ton)	10.70
Total value in 2006 (PhP million)	172.21

Sources: Updated from Sheeran (2006) that also cited Villarin et al (1999) and Lasco and Pulhin (2000); CER prices from www.treasury.govt.nz/government/liabilities/kyoto/carbonprice/kp-price-est-june07.pdf

Coastal Protection

Several studies have estimated the coastal protection functions of coral reefs and mangroves (Appendix Table 15). The estimate of Burke *et al* (2002) for Philippine coral reefs is used. The annual net benefit of coral reefs from coastal production is placed at $326 million or $12,540 per km^2, which is computed from the value of avoided damages in the coastal zone that depends on the level of economic activity and infrastructure development. Assuming that the estimate is for 2001, the coastal protection function has a value of PhP16.62 billion (PhP50.99=US$). The equivalent amount in 2006 is PhP20.2 billion for the entire country. For mangroves, the estimates for Philippines are based from Samonte-Tan (2005) which used benefits-transfer. The estimated value of protection function from mangroves is over PhP 40,000 per ha equivalent to PhP 8.5 billion for the entire country. On an annual basis, the figures are adjusted by the probability of occurrence of a major disturbance in the coastal zone, assumed at once every decade.

Waste Assimilation

The environment is a receptor of wastes generated by economic activities. Firms, household and other sources of waste derive benefits from the environment to the extent that no charges are levied on their waste discharges. The value of the waste assimilation services maybe represented by abatement costs if such services of the environments are not available. The Environmental and Natural Resources Accounting Project (ENRAP) estimated the value of the environmental waste disposal services to water in 1995 measured by the annual cost of mitigation (capital, maintenance and operating expenses) using technologies appropriate for each source and the type of effluent. Water effluents include BOD5, suspended solids, total dissolved solids, oil and grease and nutrients such as nitrogen and phosphorus.

The ENRAP estimates are projected to 2006 using the percentage change of monitored water bodies with a different classification (deterioration) between the two periods. This assumption could reflect the abatement measures instituted and the change in pollution loads over time. The monitoring data of the DENR-Environment Management Bureau (EMB) showed 2 sites out 41 have been reclassified – from class B to C. This is arguably an underestimate of the extent of pollution considering that the classification is based from a range of values of water quality parameters. It is likely that some sites may have deteriorated but are still within the range of their classification in 1995. It is further assumed that 25% of discharges end up in coastal and marine waters, recognizing that the biggest impact would be on rivers and other freshwater ecosystems and that open marine waters are able to assimilate wastes better than enclosed freshwater bodies. The share of waste disposal services by ecosystem is based from the share of each ecosystem to area of nearshore waters. The results shown in **Table 2.14** indicate that the total value of such waste assimilation services reached almost PhP 6.9 billion in 2006. The attribution to coastal ecosystems is shown in the succeeding sections. It is noted that other factors such as oceanography, wind direction and location of the ecosystem largely determine the impacts of the pollution.

2.1.4 Supporting Services

For coastal and marine ecosystems, provisioning of habitat, soil formation and retention and nutrient cycling are the major supporting services. The benefits from nutrient cycling define the interlinkages among the various coastal ecosystems. Such benefits are already reflected in the provisioning and cultural services and hence not included in the analysis to avoid double counting. The supporting services from coastal ecosystems include the provision of habitat for coastal and marine aquaculture that is done in cages, fishpens and other contraptions that do not require conversion or destruction of any coastal ecosystem. In the country, mariculture precedes freshwater aquaculture with oyster culture reported as early as the 1930s. However, the real growth in mariculture did not take place until the farming of carrageenophyte seaweeds was introduced in the 1970s. With seaweeds, mariculture now produces more than brackishwater and freshwater aquaculture combined (**Table 2.15)**. (Appendix Tables 16a and 16b list the time-series data.) Seaweeds alone comprise 70% of total production in volume terms. Mariculture gradually diversified with improvements in technology. The production of milkfish in fish cages is now widespread and the number of mariculture species continues to grow and now includes green mussels, grouper, rabbitfish, lobsters, abalone, among others. Net values are estimated at about PhP 2.78 billion in 2006.

Table 2.14 Value of waste disposal services to water, 1995 and projections for 2006

Sector and Subsectors	Total (PhP million)	%
Agriculture, forestry and fishery	**274.00**	0.00
Agricultural crops production		
Livestock, poultry and other animal products	274.00	
Forestry		
Mining and quarrying	**3,663.55**	0.05
Metallic ore mining	3,650.00	
Non-metallic mining and quarrying	13.55	
Manufacturing	**252.47**	0.00
Manufacture of food, beverages and tobacco	137.91	
Textile, wearing apparel and leather industries	40.04	
Manufacture of wood and wood products including furniture and fixture	4.47	
Manufacture of paper and paper products; printing and publishing	22.73	
Manufacture of chemicals and chemical products, petroleum, coal, rubber and plastic products	23.14	
Manufacture of non-metallic mineral products	9.07	
Basic metal industries	10.30	
Manufacture of metal products, machinery and equipment	4.82	
Community, social and personal services	**0.42**	0.00
Medical, dental, other health and veterinary services	lumped with HH	
Personal and household services	0.42	
Restaurant and hotels	lumped with HH	
Household sector (range is from 7,427,000-12,039,000; average is used)	**9,733.00**	99.94
Total (in 1995 pesos)	**13,923.45**	**100.0**
Equivalent value in 2006 with no change in level of discharges	**26,186.66**	
Value in 2006 (% increase based from number of water bodies with lower classification from 1995)	27,464.06	
Value in 2006 (assuming 25% end up in coastal and marine waters)	6,866.01	
Breakdown by ecosystem (based on share of nearshore areas)		
Mangroves	53.83	
Seagrass	25.18	
Coral reefs	695.11	
Other coastal	6,091.89	

Sources of 1995 data: Orbeta (1994) and Morales et al (1997)

Table 2.15 Volume and net value of mariculture production by region, 2006

	Quantity (mt)				Net Value (PhP million)			
	Fish Cage	Fish Pen	Oyster, Mussel, Seaweeds	Total	Fish Cage	Fish Pen	Oyster, Mussel, Seaweed	Total
I	34,695	10,100	3,602	48,397	597.2	173.4	7.5	778.1
II			1,708	1,708			1.8	1.8
III	1,985	127	6,931	9,043	34.8	2.1	16.4	53.4
IV-A	16	433	35,326	35,775	1.1	8.5	53.1	62.6
IV-B			400,892	400,892			415.4	415.4
V	70		51,295	51,365	1.6		69.2	70.8
VI	27	1,311	62,734	64,072	2.2	19.2	53.1	74.5
VII	703	12	94,004	94,718	11.8	0.3	48.5	60.6
VIII	5,738	14	20,648	26,400	158.4	0.2	36.7	195.3
IX	7	21	211,591	211,619	0.3	1.4	221.8	223.5
X	13		33,803	33,816	0.3		63.3	63.5
XI	2,404	1,715	2,691	6,810	44.1	31.3	3.5	78.8
XII	1,030		36	1,066	27.2		0.1	27.3
ARMM		2	19,489	19,491		0.3	635.1	635.3
CARAGA	138	60	560,685	560,883	6.5	4.7	22.9	34.2
Total	46,828	13,794	1,505,435	1,566,057	885.5	241.4	1,648.2	2,775.1
Source: BFAR (2006)								
Gross value of mariculture production reached PhP 11.1 billion. Net values are assumed at 25% of gross values.								

2.2 Summary of Net Benefits by Ecosystem

The benefits from CMR are summarized in **Table 2.16** and illustrated in **Figure 2.1**. The total net benefits amounted to over PhP 24 billion in 2006. The percentage shares of provisioning, cultural and regulating services are within a wide range from over 2% (cultural) to over 45% (provisioning). The net benefits from capture fisheries and mariculture combined for almost 56%, followed by waste assimilation services (28%) and shoreline protection (12%). Recreation values are minimal. Actual and potentially marketable goods and services include fisheries, timber from mangrove forests, fish from mariculture, and recreation to the extent that fees are collected equivalent to the WTP, accounted for almost 58% of the total value while the remainder is accounted for by nonmarketed values. Across ecosystems, the most productive is the “other coastal” category, with 62% of the total at almost PhP 15 billion in 2006. This is followed by coral reefs, oceanic, mangroves and seagrasses. The contribution of the living coastal ecosystems – mangroves, seagrasses and coral reefs – is about a quarter of the total.

Table 2.16 Summary of net benefits from coastal and marine resources, 2006 (million PhP)

Benefits	Coastal					Oceanic	Total	
	Mangrove	Seagrass	Coral Reef	Other Coastal	Sub-Total		Amount	%
Provisioning								
Fisheries	143.1	56.7	997.6	5,912.4	7,109.8	3,176.9	10,286.7	42.7
Timber	595.2				595.2		595.2	2.5
Sub-total	*738.4*	*56.7*	*997.6*	*5,912.4*	*7,705.0*	*3,176.9*	*10,881.9*	*45.2*
Cultural								
Recreation	26.5		94.7	125.6	246.8	-	246.8	1.0
Education/reseach	7.5	8.3	10.1	4.7	30.6		30.6	0.1
Existence			199.3	16.8	216.1	1.4	217.5	0.9
Sub-total	*34.1*	*8.3*	*304.1*	*147.0*	*493.5*	*1.4*	*494.8*	*2.1*
Regulating								
Carbon Sequestration	172.2				172.2		172.2	0.7
Shoreline protection	854.1		2,018.4		2,872.5		2,872.5	11.9
Waste assimilation	53.8	25.2	695.1	6,091.9	6,866.0		6,866.0	28.5
Sub-total	*1,080.1*	*25.2*	*2,713.5*	*6,091.9*	*9,910.8*	-	9,910.8	*41.2*
Supporting								
Mariculture				2,775.1	2,775.1		2,775.1	11.5
TOTAL	**1,852.6**	**90.1**	**4,015.2**	**14,926.5**	**20,884.3**	**3,178.3**	**24,062.6**	**100.0**
Percent	7.7	0.4	16.7	62.0	86.8	13.2	100.0	

Notes:

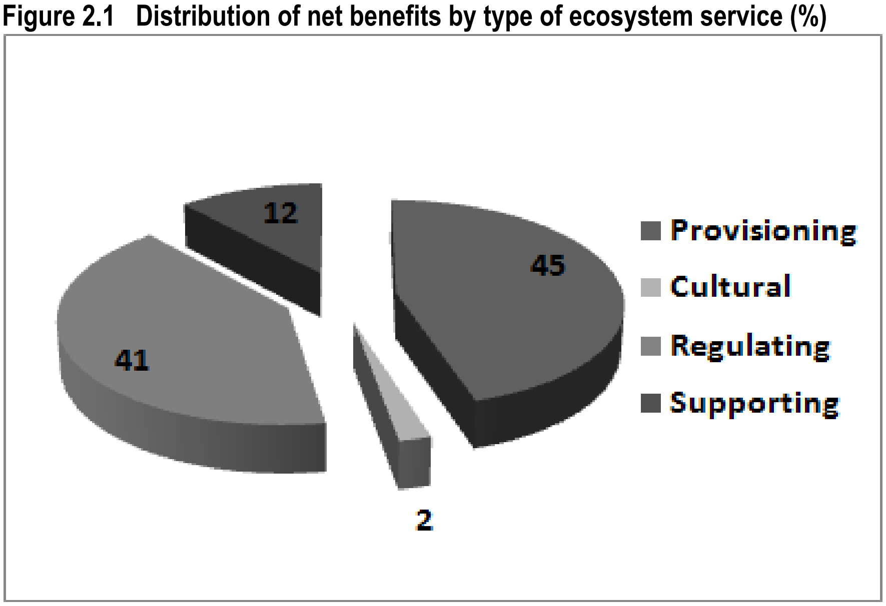
1 Value of shoreline protection assumes 10% probability of occurence of major disturbances that will have widespread impact on the coastal zone. This is based from a cursory analysis of the frequency of major storms in the country over the past 60 years.

2 Existence values are for the survey sites of studies cited.

3 Waste assimilation pertain to avoided costs to mitigate environmental pollution on coastal and marine waters.

4 Derivation of other values in this table is discussed in preceding sections.

Figure 2.1 Distribution of net benefits by type of ecosystem service (%)



The "standardized" benefits based on area of each coastal and marine ecosystem are listed in **Table 2.17**. Across ecosystems, the highest is for mangroves, with coral reefs a distant second. The contribution to total value by type of net benefit is shown in the second panel of the table. Provisioning services is highest for seagrass beds while regulating services dominate in mangroves, coral reefs and other coastal ecosystems. For all ecosystems, however, the share of provisioning services exceeds that for regulating services by a small margin. These results show which type of service will be delivered by specific conservation management activities. Similarly, if the objective is to maximize a specific type of service (e.g., provisioning, cultural or regulating), the results would indicate which CMR will have to conserved or managed.

Table 2.17 Summary of net benefits from coastal and marine ecosystems per unit area, Philippines, 2006

Ecosystem	Area (km^2)	Provisioning	Cultural	Regulating	Supporting	Total
Amounts in pesos/ha						
Coastal	266,200	289	19	372	104	785
Mangrove	2,091	3,531	163	5,165	-	8,859
Seagrass	978	579	85	257	-	921
Coral Reef	27,000	369	113	1,005	-	1,487
Other Coastal	236,131	250	6	258	118	632
Oceanic	1,934,000	16	0	-	-	16
All Ecosystems (per ha)	2,200,200	49	2	45	13	109
Percent to row total						
Coastal		36.9	2.4	47.5	13.3	100
Mangrove		39.9	1.8	58.3	-	100
Seagrass		62.9	9.2	27.9	-	100
Coral Reef		24.8	7.6	67.6	-	100
Other Coastal		39.6	1.0	40.8	18.6	100
Oceanic		100.0	0.0	-	-	100
All Ecosystems		45.2	2.1	41.2	11.5	100

2.3 Distribution of Net Benefits

The goods and services from CMR are allocated among local, national and global beneficiaries. Local beneficiaries are those within the coastal villages and municipalities and adjacent areas with the rest of the country constituting the national beneficiaries. Global beneficiaries refer to the rest of the world. The following assumptions are made in the analysis. In the case of fisheries, the value of catches from the municipal sector constitutes local benefit while those of the commercial sector are national benefits. That municipal catches primarily benefit the coastal and adjacent areas may overestimate the local benefits as a considerable portion of that production is transported all over the country. The value of exported live ornamental fish is a global benefit. Commercial catches in oceanic waters, which are primarily tuna species, are national and global benefits. In the case or recreation, distinction is made between local and foreign tourists. Education and research and existence values are national benefits. Shoreline protection and waste assimilation functions accrue to local communities while carbon sequestration and exports of fisheries products benefit the global community.

The results shown in **Table 2.18** indicate the distribution of benefits from CMR by ecosystem. Most or about 66 percent of the benefits from all coastal ecosystems (mangroves, seagrass, coral reefs and other coastal) accrue locally. For coral reefs and other coastal ecosystems, local benefits also dominate due to the existence values. The regulating functions such as shoreline protection and waste assimilation are quite huge and contribute a large share to local benefits. For all ecosystems, over 65% of the total benefits accrue locally, almost 29% nationally and about 6% globally. The results show that the impetus for coastal and marine conservation should be for the primarily benefit of the local (coastal) population and for the country as a whole. The proportion of global benefits is relatively small and covers specific goods and ecosystem services. Mangrove and seagrass conservation would benefit local communities more compared to other ecosystems.

Table 2.18 Distribution of benefits from coastal and marine resources (amounts in PhP million)

	Local		National		Global	
Ecosystem/Benefit	Amount	% of column total	Amount	% of column total	Amount	% of column total
A. Mangrove Forests						
Amount	*1,626.1*	*10.3*	*54.2*	*0.8*	*172.2*	*12.8*
% of row total	*87.8*		*2.9*		*9.3*	
B. Seagrasses						
Amount	*81.1*	*0.5*	*9.0*	*0.1*		
% of row total	*90.0*		*10.0*			
C. Coral Reefs						
Amount	*3,335.2*	*21.1*	*595.5*	*8.6*	*84.4*	*6.3*
% of row total	*83.1*		*14.8*		*2.1*	
D. Other Coastal						
Amount	*9,637.5*	*61.1*	*5,238.7*	*75.5*	*50.2*	*3.7*
% of row total	*64.6*		*35.1*		*0.3*	
E. Oceanic						
Amount	*1,094*	*6.9*	*1,043*	*15.0*	*1,041*	*77.2*
% of row total	*34.4*		*32.8*		*32.8*	
F. All Ecosystems						
Provisioning	5,989	38.0	3,814	55.0	1,078	80.0
Cultural	47	0.3	351	5.1	98	7.2
Regulating	9,739	61.7	-	-	172	12.8
Supporting	-	-	2,775	40.0	-	-
Amount	*15,774*	*100.0*	*6,940*	*100.0*	*1,348*	*100.0*
% of row total	*65.6*		*28.8*		*5.6*	*100*

III

THE COSTS OF ENVIRONMENTAL DEGRADATION OF COASTAL AND MARINE RESOURCES

Following from the framework, environmental damages constitute the foregone net benefits from the deterioration of ecosystem services resulting from mismanagement of CMR and from any outside anthropogenic stressors such as conversion, land-based pollution and climate change. Each stressor is discussed in this chapter to provide the context for the estimation of the costs of depletion and environmental degradation. The costs of degradation arising from each stressor are estimated below.

3.1 Unsustainable Fishing and Habitat Degradation and Loss

The estimates of the costs of depletion from capture fisheries are based from the difference between net benefits from potential and actual yields. Estimates of potential yields are discussed in the preceding chapter. Actual fish yields are the reported catches in 2006. Some adjustments are made from the following in estimating the costs of depletion. First, oceanic catches are set equal to the potential yield because catches are deemed overstated. This is because fish caught by foreign vessels outside the Philippines but are unloaded in local ports to supply canneries in Mindanao are reported as local production. Second, for mangroves and coral reefs, actual yields are based from the current status of these ecosystems and not from the attributed catches from the fisheries statistics, which were both discussed in the preceding chapter.

This study estimates depletion and degradation separately. Depletion or depreciation refers to the costs associated with overexploitation or "mining" primarily of the fish stock or biomass. Degradation pertains to those associated with all the other stressors – pollution, conversion, climate change, etc. The level of attribution of damages from ecosystem degradation followed the available data. The costs due to depletion and degradation by ecosystem are shown in **Table 3.1**. The total is placed at about PhP 2.6 billion in 2006 with 81% accounted for by fish species and the remainder by non-fish species. Across ecosystems, over half (52%) is attributed to other coastal areas (excluding coral reefs and mangroves) and seagrass beds. This is followed by coral reefs at 40% on account of the extensive deterioration of coral reef ecosystems as discussed in the preceding chapter.

3.2 Coastal Development: Conversion and Reclamation

The coastal zone is a multi-use zone with various economic activities which, in most cases, compete with the conservation of coastal and marine ecosystems. The social benefits from the use of the coastal zone should be weighed against and social costs, including the foregone benefits. This study provides inputs in such social decisions. Coastal development includes the conversion of mangroves into fishponds and the reclamation of the coastal zone. The conversion of mangroves into fishponds has been prohibited decades ago but the impacts may still be felt in the present time. Reclamation is being undertaken in areas where land has become limiting for huge infrastructure development. The conversion of mangroves into fishponds covers an approximate area of 239,323 ha, which is the same as the area of brackishwater fishponds reported in the Philippine fisheries statistics in 2006. On the other hand, coastal areas that have been reclaimed reached a total of 2,242 ha as of 2006, primarily in Cebu and Manila Bay (Appendix Table 17). It is assumed that the reclaimed areas are distributed as follows: mangroves (25%); coral reefs (25%); other coastal (50%). The valuation of the impacts of reclamation follows this assumption.

Table 3.1 Estimated damages from degradation and depletion from capture fisheries, 2006

	Yield (mt/yr)				Difference		
	Potential		Actual[a]		Qty	Net Value	
						Million PhP	%
Fisheries	2,100,000		1,703,446	b	396,554	2,088	80.9
Mangrove[a]	54,859		22,943		31,916	161	6.2
Coral Reef[a]	213,393		109,499		103,894	592	23.0
Oceanic	300,000		604,904	b	(304,904)	n.a.	n.a.
Others[e]	1,531,749		1,271,004		260,745	1,335	51.8
Non Fish[f]	153,718		66,394			491	19.1
Mangrove[a]	16,110		6,738		9,372	47	1.8
Coral Reef[a]	137,607		59,656		77,951	444	17.2
Combined	2,253,718		2,074,744		178,974	2,579	100.0
Mangrove	70,969	c	29,681		41,288	208	8.1
Coral Reef	351,000	d	169,155		181,845	1,036	40.2
Oceanic	300,000		604,904		(304,904)	n.a.	n.a.
Others	1,531,749		1,271,004		260,745	1,335	51.8

a/ Actual fish and non-fish yields for mangroves and coral reefs is computed using the proportion of the estimated catches in 2006 (Tables 2.7 and 2.8) and not from reported catches in the same year (Table 2.2) for consistency in estimating potential and actual catches by ecosystem.

b/ Actual catch is adjusted downwards (refer to text for explanation).

c/ Potential yield for mangroves is based from the original mangrove area of 500,000 ha.

d/ Potential yield from coral reefs is based from reefs in good condition using area of 27,000 km^2.

e/ Others refer to the other ecosystems for which no separate estimates of potential yields exist - other coastal and seagrass beds.

f/ Non-fish refers to marine mammals, invertebrates and marine plants.

Conversion and reclamation entail loss of ecosystem functions and services such as fish, timber and carbon sequestration from mangroves, ecotourism, and shoreline protection (**Table 3.2)**. The total foregone net benefits from the conversion of mangroves into fishponds amounted to over PhP 2.5 billion in 2006. The foregone net benefits from mangrove conversion are much lower compared to the gross value of aquaculture production (PhP 5.51 billion) from brackishwater fishponds in the same year but higher compared to the net benefits of PhP 1.38 billion, which is assumed in this report at 25% of gross value. This comparison provides the justification for mangrove conversion and management. The damages from reclamation, on the other hand, are relatively smaller as the area reclaimed covers only 2,242 ha. The damages are dominated by foregone shoreline protection services followed by cultural services. However, where coastal reclamation incorporated protection measures, shoreline protection services may not have been lost.

3.3 Coastal and Marine Pollution

The impacts of pollution on the coastal and marine environment is primarily in the form of habitat degradation resulting in the decline in fisheries productivity, fish kills, red tides, and the near collapse of tourism activities in severely affected areas. Impacts on human health may be enormous through higher morbidity and mortality from contact with polluted coastal waters and ingestion of red-tide affected marine organisms. In this section, the impacts of pollution will be ascertained. Vital information toward the estimation is the status of coastal and marine waters in the country (**Table 3.3)**. Of the 45 areas monitored by the Environmental Management Bureau of the DENR, the largest number falls under Class SB, followed by Class SC, Class SA and SD. Class SB is suited for recreation such as bathing, swimming, skin diving, etc and as spawning for fish species for aquaculture.

Table 3.2 Net damages from conversion and coastal reclamation, 2006 (in PhP million)

Benefits	Affected Ecosystems				
	Mangrove	Coral Reef	Other Coastal	Total	%
Conversion to fishponds					
Area affected (ha)	239,323			239,323	
Provisioning					
Fish[a]	163.83			163.8	8.0
Timber	681.21			681.2	33.2
Cultural (recreation)	30.38			30.4	1.5
Regulating					
Carbon Sequestration	197.09			197.1	9.6
Shoreline protection[b]	977.51			977.5	47.7
Sub-total	2,050.02			2,050.0	100.0
Sub-total (excluding fish)	1,886.19			1,886.2	
Reclamation					
Area affected (ha)	561	561	1,121	2,242	
Provisioning					
Fish[a]	0.38	0.21	0.28	0.87	0.2
Timber	1.60			1.60	0.3
Cultural (recreation)[b]	0.07	32.40	0.01	32.48	7.1
Regulating					
Carbon Sequestration	0.46			0.46	0.1
Shoreline protection[c]	2.29	419.01		421.30	92.2
Sub-total	4.80	451.62	0.29	456.71	100.0
Sub-total (excluding fish)	4.42	451.41	0.01	455.83	
TOTAL (conversion and reclamation)	**2,054.82**	**451.62**	**0.29**	**2,506.73**	

a Decline in fish production is indicated in this table to reflect the total damages but are already captured in the damages to fisheries from all sources. These are not reflected in total damages (Table 3.8) to avoid double counting.

b Based from Montenegro et al (2005) assessing the Cordova reclamation project in Cebu. This assumption implies that the reclamation sites are areas of high recreation potential.

c Assumes 10% probability of occurence of major disturbances that will affect the coastal zone over extensive areas.

Impacts of Marine Environmental Pollution on Human Health[14]

While recreation in coastal areas is generally considered as a positive experience for human health, it has become otherwise in some locations. Untreated wastewater discharges and indiscriminate garbage disposal have led to pollution of coastal areas that pose risks to human health. The literature is replete with epidemiological studies that enteric and respiratory diseases can result from contact recreation in coastal waters contaminated with pathogenic micro-organisms. The extensive analysis made by WHO in 1998 (as cited in GESAMP 2001) estimated that bathing in marine waters with a mean concentration of 50 fecal streptococci per 100 ml will result in infection and illness in 5% of adult bathers even with just single exposure. The susceptibility among children is higher.

Table 3.3 Classification of monitored coastal and marine waters in the Philippines, 2006

Classification	Number
Class SA Waters suitable for fishery production, tourism, marine parks, coral reef parks, and reserves	5
Class SB Waters intended for recreation such as bathing, swimming, skin diving, etc., and as spawning areas for bangus and similar species	21
Class SC Waters intended for recreation, boating, fishery, and as mangrove areas for fish and wildlife sanctuaries	16
Class SD Waters used for industrial purposes such as cooling	3
Total	45

Source: DENR-EMB

The PEMSEA (2006) report for Manila Bay, perhaps the most polluted coastal water body in the country, provides the basis for the estimates of health impacts. The cost of morbidity is the sum of the cost of medication and foregone income while recuperating from applicable illness such as diarrhea, typhoid, hepatitis and poliomyelitis. The cost of mortality is the foregone income[15] from premature death. The results shown in **Table 3.4** pertain to 2002, which are adjusted to 2006 using the change in minimum basic wage between the two periods. The total of 401 million for 2006 alone is already considerable. Unfortunately, there is no readily available information for "raising" this amount for the entire country.

Harmful Algal Blooms (Red Tides)

Red tide[16] or harmful algal bloom refers to the coastal phenomenon where water is discolored by high algal biomass or concentration of algae. Red tides occur when an algae rapidly increases in numbers to the extent that it dominates the local planktonic or benthic community. The inducing factors include environmental conditions such as warm sea surface temperatures and high nutrient content. In the Philippines, red tides have affected 22 coastal waters in the country between 1983 and

[14] Discussion is based primarily from the linked document below that is the web version of GESAMP (2001): http://www.oceansatlas.org/unatlas/uses/uneptextsph/wastesph/243gs71041.html

[15] The procedure for estimating components of the costs of mortality and morbidity is described in detail in PEMSEA (2005). Estimation of foregone earnings from mortality makes use of the methodology by Ricker (1967) which considers life expectancy of an average individual affected, employment rate and average earnings by province and discount rate of 15 percent.

[16] The description of red tides is based from the publication of the BFAR entitled "Frequently-Asked Questions on Red Tide".

2004. Shellfish are particularly prone to toxin contamination as they feed by filtering microscopic food out of the water including toxic planktonic organisms if present. Human consumption of affected shellfish can cause paralytic shellfish poisoning. The harmful toxin immediately affects the nervous system resulting in muscular paralysis and in severe cases, to fatal respiratory paralysis.

Table 3.4 Cost of morbidity and mortality from diseases associated with exposure to polluted marine waters in Manila Bay

Disease	Amount (PhP million)
Morbidity costs (income loss due to diarrhea, typhoid, hepatitis and poliomyelitis): 2002 pesos	15.8
Mortality costs (income loss due to premature death due to water-borne diseases): 2002 pesos	309.5
Total	325.2
Morbidity costs (equivalent amount in 2006)	19.5
Mortality costs (equivalent amount in 2006)	382.2
Total	401.7

Source: PEMSEA (2006)

Note: Costs are adjusted using the percent increase in daily minimum basic wage rates between 2002 and 2006 for agricultural workers in the National Capital Region at 23.5%. Income losses are primarily measured by wage rates.

The recorded paralytic incidence in the country from 2002-2006 is listed in Appendix Table 18. In 2006, red tide was reported in three locations with 86 cases, 10 of which were fatal. The valuation of these damages includes the following: morbidity – cost of medication and foregone income during recovery period; mortality cases – foregone lifetime earnings due to premature death (**Table 3.5**). The cost is minimal (PhP 3.5 million) compared to the health cost of pollution, probably due to the relatively intense media attention on red tide incidences. Shellfish bans during red tide occurrences displace affected fisherfolks and affect fish supply. These impacts are not estimated in this study for lack of data. In extreme circumstances, some countries have imposed bans on the imports of fishery products from the Philippines. Such were the cases in 1982, 1992 and 1993 red tide incidents when Japan and Singapore banned the importation of shrimps/prawns from the Philippines.

Fish kills

Fish kills are triggered by a number of factors, including harmful algal blooms, low dissolved oxygen, and high concentration of certain elements and chemicals in coastal waters. All of these causes may be associated with water pollution. Fish kill data from BFAR were assessed and incidents affecting coastal and marine waters are presented in Appendix Table 19. Not all fish kill occurrences have reported an approximate quantity and value of damages. In some cases, the reports are based from unverified media reports (e.g., print, radio). The total value of 3 fish kill incidents in coastal and marine waters (out of total 15 incidents in 2006) was over PhP 2 million. This is clearly an underestimate of the severity of the damages from fish kills considering that there was no report of value in 12 other relevant incidents.

Table 3.5 Costs of reported paralytic shellfish poisoning incidents in the Philippines, 2006

Item	Siaton, Negros Oriental	Sorsogon Bay	Los Baños, Laguna	Total
Morbidity				
Reported number of cases	7	74	5	86
Unit cost of morbidity (PhP)	6,042	5,462	7,250	
Total cost of morbidity (PhP)	42,291	404,157	36,249	482,697
Mortality				
Reported number of deaths	-	7	3	10
Unit cost of mortality (PhP)	-	275,691	365,962	
Total cost of mortality (PhP)	-	1,929,839	1,097,886	3,027,725
Total		2,333,996	1,134,135	3,468,131

Sources: Furio and Gonzales (2002); Marine Biotoxin Monitoring Unit, Fisheries Resources Management Division, BFAR.

Notes: Unit costs are derirved from PEMSEA report for Manila Bay referring to 1998 data. These are adjusted to 2006 using changes in wage rates and wage differences between NCR and the regions affected. Cost of morbidity includes foregone earnings for duration of illness and cost of medication.

Oil Spills

In an archipelagic country like the Philippines, the occurrences of accidental oil spills may be high considering the naval transport of merchandise, including fossil fuel products. The incidence of oil spills is 2006 is shown in Appendix Table 20. One of these is the Guimaras oil spill, considered a major disaster to date in terms of volume of oil spill and environmental impacts. Gross damages from the oil spill is placed at over a billion in 2006 with net damages at over PhP 352 million (**Table 3.6**). Attribution of the total cost across ecosystems is based from the area and the productivity. The worst affected are coral reefs because of the total area affected covered over 27 km^2. Petron Corporation, which hired the oil tanker, commissioned Silliman University to estimate the damages from the disaster but the report is not officially released for public consumption. The Guimaras disaster though may be considered an extraordinary event, however.

Mine Tailings

Toxic mine tailings are supposed to be contained in dams constructed in major mining sites to prevent discharge into rivers and to coastal and marine waters. Dam failure could be a potential big source of pollution, but the last major disaster was in 1996, when the tailings dam of Marcopper Mining Corporation collapsed and released at least 2 million mt of mine tailings. Extensive damages were observed in Boac River and Calancan Bay. The analysis by Bennagen (1998) indicated that minimal impacts on the coastal and marine environment 10 years could have occurred after the disaster (2006) even if only short term remedial measures have been instituted. Therefore, no separate estimate is included in this paper.

Table 3.6 Estimated net damages by ecosystem from the Guimaras oil spill (amounts in PhP million)

	Mangroves	Seagrass	Coral reefs	Coastline	Fishponds	Total	%
Area[a]	478	70	2,723	234	806		
Damages/Costs	Amounts in PhP						
Fish[b]	21.75	1.37	56.26		0.27	79.64	22.6
Gleaning[b]	3.60	0.83	15.23	1.41		21.06	6.0
Tourism[c]			8.14	32.54		40.68	11.5
Indirect uses	0.07		3.63			3.70	1.1
Clean-up costs[d]	52.33			52.33		104.66	29.7
Assessment costs[e]	2.00	2.00	2.00	2.00	2.00	10.00	2.8
Non-use values[f]	28.40	1.50	30.37	31.44	0.81	92.52	26.3
Total	108.15	5.70	115.62	119.73	3.07	352.27	100.0
%	30.7	1.6	32.8	34.0	0.9	100.0	

Sources of basic data: Subade (2008), except for clean up costs which came from NDCC.

[a]Area came from NDCC (2006); coastline figure is in km; the rest are in ha.

[b]Net damages to fisheries is computed at 10% of the gross value; losses from gleaning is computed at 100% of gross value as value of labor is considered minimal; 25% from aquaculture.

[d]Tourism is divided between coral reefs and coastline with 20:80 ratio.

[d]Clean-up costs are divided equally between mangrove forests and coastline.

[e]Assessment costs represents the grant to UP Visayas from the Calamity Fund to conduct studies. It is divided equally among ecosystems.

[f]Willingness-to-contribute to a trust fund to minimize oil spill incidents; interpreted as the cost of preventive measures. The breakdown follows the distibution of total costs across ecosystems.

3.4 Climate Change

The first ever mass-bleaching in the Philippines was reported in 1988-99. It began in Batangas in June 1988 and then proceeded nearly clockwise around the Philippines, correlating with anomalous sea-surface temperatures. Reefs off northern Luzon, west Palawan, Visayas and parts of Mindanao were affected. Bolinao was worst-hit areas with average bleaching at 28% reaching 80 percent in some areas.

The analysis made in this paper assumes that the coral bleaching event in 1998 has protracted impact, specifically, 10% of the immediate impacts are still felt in 2006. This assumption may be supported by the fact that coral reefs grow very slowly and may not have fully recovered even 8 years after the bleaching event. It is further assumed that the site-specific studies of the extent of bleaching mirrors the situation in the entire province. Thus, the damages are based from the total area of coral reefs in affected provinces using the proportion of bleached area from site-specific studies. Based from the available literature, the provinces with reported bleaching events that have been verified on-site include Pangasinan, Mindoro, Palawan, Negros Oriental, Negros Occidental, Bohol and Cebu. Following from these assumptions, the massive coral bleaching event in 1998 had a protracted estimated damages of about PhP 2.1 million in 2006 (**Table 3.7**), from foregone benefits from ecotourism and fisheries only. Protective functions of coral reefs are not estimated with the assumption that bleached reefs have not crumbled and have re-established over time.

Table 3.7 Estimated foregone recreational benefits due to 1998 coral bleaching

Coral bleaching location	Extent of coral mortality (%)	Coral reef area (ha)		Foregone benefits from SCUBA diving (PhP '000)		Foregone fish yields (PhP '000)		Total (PhP '000) in 2006
		Provincial area	Bleached area	1998	2006	1998	2006	
Pangasinan								
Bolinao[a]	27.9	9,800	2,734	573	57	282	28	85
Negros Occidental								
Danjugan Island[b]	35-90	-	-					
Campomanes Bay[e]	29	-	-					
Sub-total	45.75	26,066	11,925			2,016	202	202
Negros Oriental								
Apo Island[c]	35	10,606	3,712	2,388	239	480	48	287
Cebu								
Pamilacan, Cebu[c]	6.4			-	-			
Sumilon, Cebu[c]	32			1,185	118			
Sub-total	19	68,482	13,149	1,185	118	933	93	212
Bohol								
Balicasag, Bohol[c]	13	60,143	7,819	51	5	376	38	43
Palawan								
Tubbataha (Site 3)[a]	46			1,461	146			146
El Nido (Bacuit Bay)[d]	30-50			482	48			48
North Palawan Shelf[a]	1-3							
Sub-total	29	414,835	121,685	1,943	194	13,188	1,319	1,513
Oriental Mindoro								
Puerto Galera[e]	29	803	237	22	2	26	3	5
TOTAL				**6,162**	**616**	**17,300**	**1,730**	**2,346**

Sources: [a]Arceo et al (2001); [b]Beger et al (2001); [c]Divinagracia; [d]Cesar (2000): [e]Wilkinson (2000)

Notes: Sites listed in column 1 are only those which were reported to have been affected by coral bleaching in 1998. In certain instances, data is reported collectively for a number of sites.

3.5 Summary of Damages

The estimated damages resulting from unsustainable fishing, coastal development, pollution and climate change are summarized in **Table 3.8** and in **Figure 3.1**. The damage estimates constitute primarily the (foregone) benefits as computed in the preceding chapter, except for impacts on human health where estimates from specific studies were used. Where possible, the damages across ecosystems are disaggregated by ecosystem. For damages associated with fisheries, distinction is made between the cost of depletion and degradation and conversion of coastal ecosystems, with the latter having impacts on fish yields, due for instance, deterioration or loss of fish habitats.

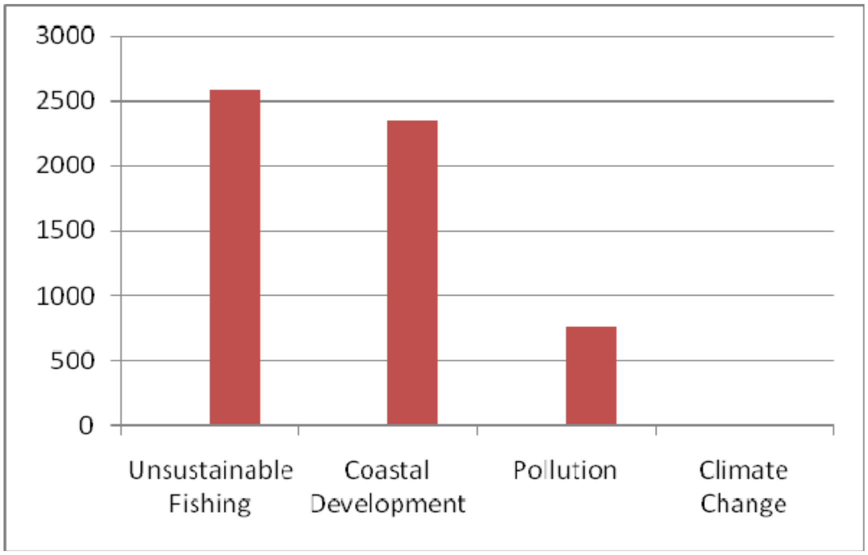
The figures provide an indication of the extent of the **net damages** to CMR according to source and by ecosystem affected. Total damages in 2006 alone reached almost PhP 5.7 billion, equivalent to about US$ 110 million. The biggest source of damages is from foregone fisheries production due to overfishing and habitat degradation, which contributed about PhP 2.6 billion or 45% of the total. Foregone benefits from coastal development accounted over PhP 2.3 billion (41%) while from pollution, the amount was about PhP 0.8 billion (13%). Damages from climate change are minimal as the only contributory factor that was valued is coral bleaching that happened in 1998. With potentially more frequent coral bleaching from climate change and the feasibility to quantify and monetize other impacts, the damages could increase exponentially. The stresses on the coastal and marine sector have affected primarily mangrove forests followed by other coastal areas and coral reefs. The foregone net benefits per unit area (ha) are also presented in the table. The highest cost is registered for mangrove ecosystems at more than PhP 10,000 per ha while the figures for coral reefs and other ecosystems are much smaller. This shows that mangrove conservation would result in higher marginal benefits compared to other ecosystems.

Table 3.8 Summary of environmental costs to coastal and marine resources, 2006 (PhP million)

Source / Impact	Ecosystem				Total	%
	Mangrove	Seagrass	Coral Reef	Other Coastal		
Unsustainable fishing, etc.						
Total related to fisheries	207.97	n.e.	1,036.33	1,335.01	**2,579.31**	**45.4**
Fisheries impacts; coastal development, pollution and climate change	169.56	0.00	0.28	0.28	**170.12**	**3.0**
Fisheries impacts from overfishing (depletion)	38.41	n.e.	1,036.06	1,074.46	**2,409.19**	**42.4**
Coastal development	1,890.61		451.41	0.01	**2,342.03**	**41.2**
Conversion to fishponds	1,886.19				**1,886.19**	**33.2**
Reclamation	4.42		451.41	0.01	**455.83**	**8.0**
Pollution	108.15	5.70	115.62	529.93	**759.40**	**13.4**
Human morbidity/mortality				401.66	**401.66**	**7.1**
Oil spill (Guimaras)	108.15	5.70	115.62	122.80	**352.27**	**6.2**
Harmful algal blooms				3.47	**3.47**	**0.1**
Fish kills				2.01	**2.01**	**<0.1**
Climate change			2.35		**2.35**	**<0.1**
Coral bleaching			2.35		**2.35**	**<0.1**
Total	**2,206.73**	n.e.	**1,605.71**	**1,864.95**	**5,683.08**	**100.00**
%	**38.83**		**28.25**	**32.82**		
Per unit area (PhP/ha)	**10,553.00**		**594.71**	**78.98**		

n.e. - not estimated

Figure 3.1 Net damages to coastal and marine resources by stressor



IV

COSTS AND BENEFITS OF SELECTED PRIORITY INTERVENTIONS[17]

The identification of interventions proceeds from the results of the preceding analyses. The criteria for the identification of priority interventions include the following:

- Should address the biggest source of environmental degradation
- Should have biggest potential reduction in environmental damages at the least cost (effective and efficient)
- Should benefit the poor
- Should be implementable

4.1 Intervention 1: Conservation of Coastal and Marine Ecosystems – Network of Marine Protected Areas (MPAs)

Background

The estimation of the benefits from CMR underscores the huge benefits that accrue primarily to local communities from coastal and marine ecosystems highlighting the potential of conservation to address development goals. Healthy ecosystems provide insurance to coastal communities against poverty, calamities and diseases. An important avenue towards conservation is through a network of marine protected area (MPA). A MPA as defined by IUCN pertains to "any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part, or all, of the enclosed environment". At an appropriate scale, a network of MPAs would contribute to global targets agreed at the World Summit on Sustainable Development in 2002 (and later in the CBD Conference of Parties in 2004) to protect and restore marine biodiversity and to maintain the natural resource base for economic and social development. A network of MPAs is where the objectives cannot be achieved by single MPAs but by a network of reserves linked by dispersal of marine organisms by ocean currents (Roberts and Hawkins, 2000; NRC 2001). While the network is designed based from biophysical linkages, there are economic implications, particularly with respect to the incremental benefits that could be derived, economies-of-scale in planning and management, and in increasing resilience of MPAs in responding to stresses, including climate change.

In the Philippines, the impetus[18] for the institutionalization of the establishment of MPAs[19] as embodied in the Philippine Marine Sanctuary Strategy (PHILMARSAST) includes the need to manage marine ecosystems, sustain fisheries utilization and assure the equitable allocation of its benefits in perpetuity. The vision is that the coastal and marine ecosystems of the Philippines achieve sustainable development, equitably providing the life-giving benefits to its happy communities. The goal is that marine reserves and sanctuaries promote integrated coastal and marine

[17] This section is written with Rex Labao. His research assistance is acknowledged for the rest of the chapters.
[18] As described in the PHILMARSAST that was prepared through the program Enhancing Sustainable Fisheries through Improved Marine Fishery Reserves and implemented by 4 academic institutions.
[19] Marine reserves and marine protected areas (MPA) are used interchangeably in this report.

management that contribute to the sustainable development of Philippine coastal communities. The strategy was formulated in 2000-2003 through a series of nationwide consultations and participatory research initiatives from a range of stakeholders. The PHILMARSAST includes, among others, the following targets: (a) achieving at least 10% of MPA in municipal waters; (b) improve MPA management effectiveness; (c) sustainable financing through public and private partnership.

As of 2006[20], the total area of MPA is placed at 397 km^2. Latest data available from the UPMSI database as of October 2007, indicate that 1,161 MPAs currently exist with another 162 sites proposed. The MPAs are classified into 8 categories: (i) artificial reefs; (ii) protected landscape/seascape; (iii) tourist zone and marine reserve; (iv) wetland; (v) mangrove swamp forest reserves; (vi) reserve, sanctuary or park; (vii) wilderness area; (viii) multiple covering more than 1 MPA category. Of the 852 MPAs with known area, the largest number of MPAs (about 70%) is under the category of reserve, sanctuary or park. Most of these MPAs are within the 11-100 ha area (48%) and less than 10 ha (35%). Considering that there are 822 coastal municipalities (out of 1,502), on the average there is at least 1 MPA in every coastal municipality. The concentration of MPAs is in the Visayan biogeographic zone with a total of 716 MPAs.

Description of the Intervention

It is projected by Aliño *et al* (2008) that at the rate the country is moving towards the target area, it would take more than a century to reach it. But the target area has not been clear; there is no definitive figure of the target area at the national level to be covered by MPAs. Aliño *et al* (2008) mentioned total coral reef area while the PHILMARSAST refers to municipal waters as the basis. However, there is no estimate of municipal waters in the Philippines that is known to the author, perhaps due to issues of delineation. For the purposes of this study, the target area is equivalent to 10% of the area of each ecosystem. It is emphasized though that other areas such as scenic seascapes should also be protected. The breakdown of the target area of MPAs is shown in **Table 4.1** based on the 10% target. The baseline areas for mangroves and seagrass beds are as indicated earlier in this paper. For coral reefs, however, the reference area is the recent UPMSI estimate of 10,199 km^2.

Table 4.1 Target MPAs in the Philippines (in ha)

Ecosystem	Total area of each ecosystem		Total target area (10% of total area)	Existing MPAs (2006)	Remaining area to be declared as MPA (ha)
	Area (ha)	% to total			
Coral reef	1,019,900	82.9	101,990	32,919	69,071
Mangrove	209,109	17.0	20,911	6,749	14,162
Seagrass	978	0.1	98	32	66
Total	1,229,987	100.0	122,999	39,700	83,299

Beyond the area target is the effectiveness in the management of MPAs. It has been recognized by the World Commission on Protected Areas (WCPA) that in Southeast Asia, including the Philippines, only 14% is estimated to be effectively managed, reflecting that the major challenge is sustaining MPAs after initial proclamation. Achieving management effectiveness is as important as

[20] Most of the data cited in this intervention are from Alino *et al* (2008).

the area target to maximize the ecosystem services. Further, the identification and design of MPAs should follow the "network" approach to improve resilience. The basis for a network of MPAs is primarily ecological but also socioeconomic. For instance, economies-of-scale in management may be achieved along the lines of a harmonized regulatory framework and integrated planning and enforcement, when MPAs are networked.

Benefits and Costs

The costs of establishing and managing MPAs are obtained from several MPAs in the Philippines (**Table 4.2**). Establishment costs include capital costs such as boats, buildings, marker buoys and expenditures on the soft components such as ordinance formulation, organization and planning. Establishment costs are spread over a 5-year period. Management costs are recurring costs such law enforcement[21] which constitute one of the biggest components of costs. Based from the UPMSI MPA database, as of 2007 the average area of existing MPAs is about 34 ha. The total establishment cost for the average MPA at about PhP 215,000 may be prohibitive for some LGUs. This is where partnership among municipal governments together with the communities and some donor organizations and NGOs should be explored.

Table 4.2 Recurrent management costs of selected MPAs in the Philippines

MPA	Location	Annual management cost (PhP)	Total Size (ha)	Annual cost per ha (PhP)	Ecosystems
Apo Island Protected Seascape and Landscape[a]	Dauin, Negros Oriental	4,438,053	681	6,517	Coral reefs
Tubbataha Reef National Park[b]	Cagayancillo, Palawan	7,902,000	33,200	238	Coral reefs
Pilar Municipal Marine Park[c]	Pilar, Cebu	528,617	179	1,706	138 has mangrove, seagrasses and coral reefs
Villahermosa Marine Sanctuary[c]	Tudela, Cebu	237,353	69	2,334	Seagrasses, Coral reefs and mangroves
Bibilik MPA[c]	Dumalinao, Zamboanga del Sur	445,297	20	14,273	Coral reefs, seagrasses and mangrove forest
Tambunan MPA[c]	Tabina, Zamboanga del Sur	710,180	103	4,854	Coral reefs, mangroves
Talisay MPA[c]	Tabina, Zamboanga del Sur	332,007	33	7,397	Coral reefs, 13 has mangroves
Militar, Sto. Nino, Sugod and Tagulo (MiSSTA) MPA[c]	Tukuran, Zamboanga del Sur	771,699	160	3,279	Coral reefs, seagrasses and mangrove forest

[a] PAMB-Negros Oriental; [b] WWF-Palawan; [c] Butardo-Toribio et al (forthcoming)

Note: Management costs for Apo Island and Tubbataha are for 2007. For other sites, average of implementation costs from year of establishment to 2006 were used.

[21] Conservation International – Philippines has initiated a study on enforcement costs in Verde Passage. The report has not been made available to the author.

The cost item that is not included in the above calculations is prior research that is needed to design a network of MPAs. Completed studies such as those for Sulu Sea that was conducted by the University of the Philippines in the Visayas (UPV) and UP-MSI (Campos *et al* 2008) are reported to cost about PhP 9 million (personal communication with one of the authors). The study investigated biodiversity corridors through the analysis of the distribution and dispersal of fish larvae and water circulation as basis for the identification of most suitable local areas as part of a network of MPAs. The costs of supporting technical and scientific studies are quite substantial but could be financed by local and international donors and NGOs as was done by Conservation International in the Sulu Sea.

Social costs have not been factored into the analysis for lack of information. Such costs emanate from the transition from open access to regulated use of CMR with short-term impacts on incomes and livelihoods. Proponents of MPAs should institute "safety nets" to secure social acceptability which is critical in the success of any MPA.

Benefits refer only to **incremental** goods and services that could be derived from the establishment and management of MPAs. Even without proper management of an area through an MPA, there are benefits that could be derived. For conservative analysis, incremental benefits refer to the gross value of provisioning services, considering that the incremental value from protection and other services may be relatively small. Moreover, in isolated coastal communities, the incremental fish catches might be the most important component of benefits from management. Further, costs of production may be nil if artisanal methods of fish capture are employed. The cost and benefit figures are shown in **Table 4.3**. Overall, the benefits outweigh the costs by about 25%. The highest difference is for mangrove MPAs. The net benefits from coral reef MPAs are quite modest although the value will increase substantially with ecotourism while the negative figure for seagrass is due to the recognized undervaluation of the benefits. Although not done in this report for lack of data, the connectivity of mangroves, seagrass beds and coral reefs should be recognized in valuing benefits, particularly in proposed MPAs that has the three ecosystems together.

The total net benefits for the target area is estimated at about PhP 187 million per year with over half accounted for by coral reefs. In aggregate terms, net benefits represent about 50% of the annualized costs, which makes a good case for investment. For the average MPA of 34 ha, the net benefits would range from PhP 49,000 to PhP 210,000 per year. On top of the net benefits from provisioning services are ecotourism and improved social well-being from healthy ecosystems and a sense of livelihood security. Successful community collaboration through a well-managed MPA brings about community pride and also benefits related initiatives.

One of the remaining issues about the management of common property resources is the fact that most of the benefits accrue to the entire community through targeted increases in sustainable fish production and livelihoods. Covering the recurrent management costs from contributions of poor fishers may be difficult if there are no incremental cash benefits from ecotourism. While in-kind contributions from the community could reduce the costs, mechanisms for covering the cash portion of the management costs should be explored and secured to sustain management activities in MPAs.

Table 4.3 Benefit-cost analysis of MPAs

	Mangrove	Seagrass	Coral reef	Total
Target MPA for entire country (ha)	14,162	66	69,071	83,299
Benefits				
Estimated potential benefits from provisioning services with protection (pesos/ha/yr)	20,872	13,541	7,409	
Actual benefits from provisioning services in 2006 (pesos/ha/yr)	12,430	5,792	3,695	
Incremental benefits (pesos/ha/yr)	8,441	7,749	3,714	
Total incremental benefits (pesos/yr)	119,542,254	513,229	256,528,571	376,584,055
Costs				
Annualized establishment costs (total cost spread over 5 years in pesos/ha/yr)	1,262	1,262	1,262	
Total establishment costs for MPA target for 5 years (PhP)	89,347,967	417,879	435,782,253	525,548,099
Annual management costs (pesos/ha/yr)	1,015	1,015	1,015	
Total annual management costs for MPA target (pesos/yr)	14,373,991	67,227	70,107,137	84,548,355
Total costs (pesos/ha/yr)	2,277	2,277	2,277	
Net Benefits				
Benefits - Costs (pesos/ha/hr)	6,164	5,472	1,437	
Benefits - Costs (for target area of MPAs)	87,298,670	362,426	99,264,984	186,926,080

Notes: Potential benefits for MPAs in seagrass ecosystems is assumed to be the average for mangroves and coral reefs.

Establishment costs include certain capital costs (e.g. boat, guardhouse/outpost), installation of marker bouys, ordinance formulation, organization and planning activities. These are based from 6 sites (Butardo-Toribio et al forthcoming).

Management costs include administrative costs (personnel, office supplies and materials, travel, etc.) and activity costs (law enforcement, IEC, training, rehabilitation, ecotourism facilities, etc.). These are computed from six sites in Butardo-Toribio (forthcoming) and addtional two sites - TRNP and Apo Island Protected Landscape/Seascape. In computing the management cost per ha, the area of TRNP used is the coral reef area of 10,000 ha.

Net benefits for MPA target (last row) is computed using annualized costs.

4.2 Intervention 2: Aquaculture for Development

Background

The biggest source of damages to CMR, as shown in this study, is from overfishing. The common paradigm to address this problem is to provide fishers with alternative sources of income that would reduce their dependence on capture fishing and thus reduce overfishing. Considering that real employment alternatives to fishers should be related to fisheries, making aquaculture pro-poor could be the way forward. Moreover, aquaculture is not only beneficial in terms of sustainable use of marine resources but could be a profitable venture to accelerate socio-economic growth and food security. The Fisheries Code of 1988 (RA 8550) defines aquaculture to include all fishery operations involving all forms or raising and culturing fish and other fishery species in fresh, brackish and marine areas. Sustainable aquaculture, as defined by the Food and Agriculture Organization (FAO), is the management and conversion of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Sustainable aquaculture is the intervention that is discussed in this section.

Aquaculture has contributed an annual average of around 1.7 million mt to fish supply for the period 2002-2006 (**Table 4.4**). For 2006 alone, aquaculture production constitutes 47% of total fish production compared to commercial capture fisheries (25%) and municipal capture fisheries (28%). While capture fisheries production has been declining, aquaculture production has been increasing. The increasing role of aquaculture relative to capture fisheries is a global trend and this is brought about by the continuing overexploitation of wild fish stocks (GOC 2008). **Table 4.5** shows that the major species produced from aquaculture are seaweeds, milkfish, tilapia and shrimps/prawns. Brackishwater aquaculture is considered to be the largest in terms of extent and value of production with milkfish and black tiger shrimps being the two main products (BFAR-PHILMINAQ, 2007).

From a global perspective, further expansion of aquaculture to bridge the gap between demand and supply and to provide livelihoods is faced with some tough issues and concerns such as the following (GOC 2008): (i) availability and access to land and water; (ii) availability and access to production inputs; (iii) the trend towards marine aquaculture and sea-ranching; (iv) the interaction between aquaculture and the environment; (v) technological development and access to financial capital; (vi) access to markets; and (vii) aquatic animal health and human health, including both sanitary and phytosanitary issues. These are very much relevant to the Philippine situation.

Table 4.4 Quantity and value of aquaculture production

Year	Quantity		Value	
	mt	% change	PhP million	% change
2002	1,338,393		35,418	
2003	1,454,503	8.7	37,199	5.0
2004	1,717,027	18.0	44,822	20.5
2005	1,895,847	10.4	49,170	9.7
2006	2,092,276	10.4	55,672	13.2
Average	1,699,609	11.9	44,456	12.1

Source: BFAR (various years)

Table 4.5 Major species produced in aquaculture fisheries, 2006

Species	Quantity (mt)	Percent (%)
Seaweeds	1,468,906	70
Milkfish	315,075	15
Tilapia	202,041	10
Shrimps/ prawns	40,654	2
Others	65,600	3
Total	2,092,276	100

Source: BFAR

In the context of the environment focus of this study, the most relevant would be the environmental implications of aquaculture. As discussed in the preceding chapter, there is co-dependence between the marine environment and aquaculture as shown by pollution-induced fish kills in fishponds, fish cages and fish pens. More intensive aquaculture technologies that are sustained by continuous feeding have resulted in the accumulation of waste causing cases of self-pollution. Similarly, aquaculture has an impact on the environment as shown by the foregone benefits from the conversion of mangroves into fishponds. The aquaculture-environment interactions have been reported in Lingayen Gulf by Padilla *et al* (1997), Padilla and Morales (1999) and more recently by Sumalde and Francisco (2006).

Description of the Intervention

A recently completed study[22] developed a medium-to-long-term strategy for Philippine aquaculture to maximize its contribution to the economy and secure food supply and livelihoods. The study recommended a strategy towards an integrated action plan and investment program that would reduce poverty and enhance the sustainability of Philippine aquaculture. The Strategy foresees a future for Philippine aquaculture that is pro-poor, globally competitive, sustainable, productive, profitable, and equitable. Its key objectives for Philippine aquaculture are: (i) improved overall productivity, sustainability, and efficiency; (ii) improved access to markets; (iii) appropriate policy, legal, and institutional support for aquaculture development; (iv) increased investment and financing; and (v) empowering the poor to participate in, and benefit from, aquaculture development (Report on the Strategy for Sustainable Aquaculture for Poverty Reduction 2007). Specific actions and policies include: (i) expansion of farming areas, wherever possible and profitable, and subject to the needs of other sectors and of environmental health; (ii) improvements in productivity through development and wide adoption of best aquaculture practices (BAPs), including innovative approaches such as polyculture; (iii) better biosecurity and health management for all farmed aquatic species; and (iv) increased investment in RDE to meet expected challenges, including disease risks, climate change, and introductions of alien species.

The Strategy specifically recommends the continued use in policymaking, planning, and action programs of its commodity-specific classification of aquaculture, namely: (i) carrageenophyte seaweeds (*Kappaphycus* spp., also known as *Eucheuma*); (ii) edible seaweeds (mainly *Caulerpa* spp.); (iii) mollusks (mussels and oysters) and other invertebrates (mud crab, *Macrobrachium*, sea cucumbers, and sea urchins); (iv) penaeid shrimps; (v) milkfish, tilapia, other marine finfish, including groupers, snappers, and siganids; and (vi) other freshwater finfish, including bighead and common carps, African catfish, and ornamental species. Pro-poor commodity-specific proposals have also been identified in the report.

Promoting aquaculture, however, requires careful management and implementation plans. The environmental impacts of aquaculture should be mitigated and regulated, if not totally eliminated. Biophysical impacts of aquaculture may include fecal discharge of fish, waste food, and impacts on genetics and biodiversity. In addition, bad aquaculture practices such as poor siting, overcapacity, overstocking and overfeeding may result to negative impacts on the environment (BFAR-PHILMINAQ, 2007). The most alarming consequence of aquaculture is habitat loss and

[22] This is a technical assistance grant to the Philippine Department of Agriculture – Bureau of Fisheries and Aquatic Resources from the Asian Development Bank (ADB) and undertaken by The World Fish Center and PRIMEX. The intervention described in this study is largely based from this report.

modification. Aquaculture affects sensitive coastal environments either by conversion or alteration. It has been recommended that a 1:1 mangrove-to-fishpond ratio be maintained to improve the balance between production and conservation. This would mean conversion of applicable fishponds to mangroves and rehabilitation of degraded mangrove forests.

Benefits and Costs

The projected costs and returns of selected marine aquaculture species are obtained from the Inland Fisheries and Aquaculture Division of BFAR. **Table 4.6** presents the results from recalculation of profit and return-on-investment (ROI) for more clarity. The general picture shows that for all commodities, a positive ROI could be expected. What is also apparent is the large difference in terms of required capital investment for milkfish and grouper vis-à-vis seaweeds, oyster, and mussel.

Seaweed production which requires the lowest investment has also a positive ROI at 86%. This industry, as indicated in Table 4.5, contributes 70% of the total aquaculture production in terms of volume. As reported by The World Fish Center and PRIMEX (2007), some forms of seaweed farming have potential in most coastal regions of the Philippines as even poor farmers could possibly afford the initial investments while operating costs may be sourced from other channels such as traders who provide working capital upfront in exchange for marketing contracts. Also, national statistics for all seaweed farming and the BFAR Commodity Road Map for Seaweeds include all regions in the Philippines as viable locations for seaweed farming. For carrageenophyte farming, certain areas in Mindanao, particularly in Regions XI and ARMM, have comparative advantages because of their clean, high-salinity waters and infrequent occurrence of typhoons.

Table 4.6. Projected cost and return analysis of selected marine aquaculture commodities (in PhP)

Item	Eucheuma nursery	Seaweed farm (Bamboo raft)	Oyster (Hanging raft method)	Mussel (Stake method)	Milkfish (Steel cage)	Grouper (floating net cage)
Farm Area (ha)	0.25	0.25	0.25	0.25	0m x 10m x 6m	5m x 5m x 3m
Culture period	60 days	45 days	3 mos.	3 mos.	3-4 mos.	5-7 mos.
No. of cropping per year	3	3	2	2	3	1
Farm price (per kg)	25	25	5	20	75	400
Investments	115,300	5,570	32,710	32,710	160,000	90,000
Operating costs	82,666	42,804	40,025	40,025	539,300	191,560
Total costs: 1 year	197,966	48,374	112,760	112,760	1,777,900	281,560
Profit/ Loss Analysis						
Sales						
1 cropping	128,550	30,033	168,750	112,760	810,000	368,640
1 year	385,650	90,100	337,500	225,520	2,430,000	368,640
Net Profit: 1 year	187,684	41,726	224,740	112,760	652,100	87,080
Return on Investment (%)	95	86	199	100	37	31

Source: Recomputed from BFAR data

4.3 National and Local Government Fisheries Registration and Licensing

Background
The need to regulate capture fisheries may be indicated by the severity of overfishing as shown by a number of studies and the estimates of the cost of fisheries depletion as discussed in the preceding chapter. The problem may be traced to the common property and "open-access" regime of exploitation in Philippine fisheries. Even in instances where municipalities have declared their municipal waters for exclusive use of their small-scale fishers, no limits have been set on the number of fishing boats. This makes the municipal waters and the fishery resources within a common property of local residents with access open to anyone who wishes to engage in fishing.

The same situation characterizes the area outside the municipal waters that is the responsibility of the national government. Any commercial fishing vessel with the requisite permits could operate in any area of the country, until mid 2004 when DA-BFAR issued FAO 223 declaring a moratorium on the issuance of commercial fishing vessel licenses. Since the commercial fishing operators have been contesting the scientists' findings of overfishing, the moratorium cited the precautionary principle for the need to maintain the current fishing effort in Philippine waters at the 2004 levels. (The precautionary principle is provided for in the Code as a basis for issuing fisheries regulations.) Simultaneously, an inventory of the commercial fishing boats, their gears and areas of operation is being conducted to aid DA-BFAR in determining the appropriate number of licenses that it may issue after the moratorium. This is move in the right direction although there is no available data to evaluate the impacts of the moratorium and to determine the remaining vessels in the industry.

Any measure to rationalize the Philippine capture fisheries sector though limited entry may be politically difficult due to the social impacts, particularly in the municipal sector. The fisheries has become an employer of last resort in coastal areas and in isolated villages, it could be the only source of food, cash income and livelihood. Thus, limited entry boils down to the choice between social and environmental objectives, unless alternative employment could be provided to fishers that may be displaced.

Description of the Intervention
In the reports prepared for the FISH (Fisheries Improved for Sustainable Harvest) project that is implemented by the Philippine Bureau of Fisheries and Aquatic Resources and supported by the USAID, registration and licensing and licensing frameworks have been developed separately for the municipal and commercial capture fisheries sectors. The reports, the preparation of which was led by the author, concluded that existing laws provide sufficient basis for improving the performance of the capture fisheries sector. The recommendations made in the FISH report are adopted here and described below.

Municipal Fisheries Sector. For the municipal sector, registration and licensing has three components: registration of municipal fishers; registration of municipal fishing vessels; municipal fisheries licensing. The scheme recommends separate registration and licensing of the fisher, vessel and fishing gear for better handle on regulating access to the fishery. Residency requirement is an important factor in registration and licensing. Implementation activities are outlined in the report and include the following:

- Conduct awareness campaigns and social marketing to facilitate social acceptance and compliance among fishers;

- Conduct fisher and fishing vessel registration and complete the database of municipal fishers, fishing vessels and gear;
- Conduct awareness-raising activities and basic orientation on rights, privileges, roles and responsibilities of fishers to emphasize the incentives of fishers in complying with the scheme;
- Implement the licensing scheme based on the fisher and vessel registries;
- Develop information database and train LGU personnel on information management;
- Provide continuous training on compliance monitoring, enforcement and evaluation;
- Link the information management systems of LGUs to the centralized information management system of BFAR for easy access to the fisheries database and for sharing of information;
- Estimate resource capacity to provide a basis for limiting entry in the long run. If the MSY cannot be immediately estimated for lack of data, the precautionary principle may also be used as basis for regulation; and,
- Evaluate the implementation of registration and licensing scheme and assess the applicability of the limited entry schemes.

Refinements to the suggested framework were also made in the FISH report.

Commercial Fisheries Sector. The objectives of registration and licensing in this sector differ compared to the municipal sector. Registration is aimed at information generation, monitoring and ensuring safety of vessels at sea. Licensing, on the other hand, is targeted to: generate information; provide a system for granting priority access rights; regulate entry and generate revenue. Several elements supported by the Fisheries Code are recommended for introduction into the registration and licensing scheme. First is area-based licensing which will specify the area(s) where a fishing vessel could operate. As a precondition for this scheme, commercial fishing grounds would have to be delineated for which fishery resource assessments should be undertaken to determine their exploitation status. Second is limited entry which refers to the issuance of a fixed number of licenses that will be guided by the exploitation status of each fishing ground. A higher number of licenses may be granted for underexploited fishing grounds while a reduction should be implemented in the overfished areas. Third is the setting of license fees based on resource rent, which is provided for in the Fisheries Code. A study commissioned by BFAR for this purpose in the early 1990s showed that recovering 5 to 10% of the potential resource rent would not have increased the fees significantly.

Benefits and Costs

Considering that this intervention does not provide a clear target for the reduction of fishing effort, particularly in the municipal sector, it is difficult to estimate the benefits and costs and this is not attempted here. Considering the general macroeconomic conditions in the country where real employment alternatives may be limited, the level of confidence is quite low in predicting the extent with which registration and licensing could reduce the level of fishing effort, towards say, the point of MSY or the more conservative maximum economic yield (MEY). Based from the surplus yield model, achieving MEY would require less reduction in fishing effort compared to MSY. Nevertheless, this should not diminish the importance of implementing the proposed intervention. Collectively, the three interventions which are mutually reinforcing, by protecting and conserving habitats through MPAs, providing real alternatives through pro-poor aquaculture and instituting a licensing scheme with the long-term objective of limiting entry, could reduce the environmental costs on CMR.

V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study was commissioned by the World Bank to contribute to the Philippine Country Environmental Analysis. The objectives are: (i) to quantify the current benefits from the CMR, (ii) to estimate the costs of environmental degradation of those resources, (iii) to analyze the costs and benefits of major possible interventions to protect the resources and (iv) to assess distributional impacts of environmental costs, as well as interventions, focusing on the benefits accruing to various direct stakeholders and the burden each group bears when the resources are depleted and degraded.

Methodology

The major coastal and marine ecosystems were identified in this study. A framework based from the Millennium Ecosystem Assessment (MA) classification of ecosystem goods and services was adopted to respond adequately to the above objectives. The goods and services are classified into provisioning (fish, timber from mangrove forests), cultural (recreation, education/research, existence), regulating (shoreline protection, waste assimilation, climate regulation), and supporting (mariculture). The net benefits from CMR are estimated using the concept of Total Economic Value (TEV). Net benefits were assumed to be a fixed percentage of the gross values. This is a simplifying and a limiting assumption considering that the level of costs is likely an increasing function of scarcity, primarily in the capture fisheries sector. As fish stocks are overexploited, harvesting costs could increase exponentially due to longer "hunting" time and the necessity to cover wider areas in search for fish, resulting in declining catch per unit of effort and therefore higher unit costs. With more data, the cost estimates may be refined.

The environmental costs associated with CMR are classified according to the nature of stressor, which includes unsustainable fishing, coastal development, pollution, climate change and invasive alien species. The valuation of costs follows from this classification. Depletion costs are associated with unsustainable fishing and computed as the difference between the value of potential sustainable production and the net value of actual fisheries production. The costs associated with coastal development are the net values of foregone goods and services from loss of habitats such as the conversion of mangroves into fishponds and reclamation of coastal areas. On the other hand, the costs of degradation of habitats resulting from pollution are estimated based from the reduction in the productivity of affected coastal and marine ecosystems. Direct costs associated with specific sources of pollution are also estimated as in the case of fish kills, oil spills and similar occurrences. As marine pollution affects human well-being, the costs of morbidity and mortality from exposure to polluted waters are also monetized although the available data pertains only to Manila Bay. The costs of the impacts of climate change, i.e., coral bleaching, are estimated from the foregone recreational benefits and net fisheries productivity. The impacts of invasive alien species were not valued due to lack of data.

In almost all cases, the valuation of benefits and costs made use of parameter estimates pertaining to the Philippines. The review of literature showed that the existing relatively large number of papers and documents has been based primarily on parameters estimated from studies in other countries which were then "transferred" to the Philippines adjusting for differences in income and prices. This procedure implies that the ecological attributes of the study site (in another country) are similar to those in the Philippines. To avoid such bias, “local” parameters are used in most, if not all, of the computations. These parameters have been generated from site-specific studies in the country, covering various ecosystem goods and services. Across ecosystems, there have been a proliferation of empirical studies on mangroves and coral reefs, on fisheries and recreational benefits, but also, there has been a noticeable absence of similar studies for seagrass/algal beds. Decades-old fisheries studies, which are still relevant, have provided useful estimates of benefits and costs of overexploitation. The above, notwithstanding, some assumptions have been made based from judgment and experience from extensive research in the sector by the author and other experts. These assumptions have been outlined clearly in the report.

The aggregation of ecosystem benefits and costs of depletion and depreciation has been carefully undertaken to avoid double-counting. In the case of fisheries, the decline in production estimated at the national level already reflects the combined impacts of all stresses that include overexploitation and the loss and degradation of habitats that support fisheries. Thus, the appropriate approach was to disaggregate the “whole” into its “components”. Along this line, the costs and benefits are disaggregated by ecosystem in order to assess their status, i.e., which among mangroves, seagrass beds, coral reefs, other coastal areas and oceanic waters provide the highest gross benefits and which are worst hit by environmental degradation. It is emphasized that some goods and services are “jointly” provided for by all ecosystems. For instance, the habitats used by many fish species over the entire life-cycle may cover more than one type of ecosystem.

A reference year is used for comparability and for easy aggregation of costs and benefits, although time-series data have been reported to allow some trend analysis. All estimates are expressed in 2006 nominal values. Some trend analysis was made, where possible.

Results

The total net benefits amounted to over PhP 24 billion in 2006. The percentage shares of provisioning, cultural and regulating services are within a wide range from over 2% (cultural) to over 45% (provisioning). The net benefits from capture fisheries and mariculture combined for almost 56%, followed by waste assimilation services (28%) and shoreline protection (12%). Recreation values are minimal. Actual and potentially marketable goods and services include fisheries, timber from mangrove forests, fish from mariculture, and recreation to the extent that fees are collected equivalent to the WTP, accounted for almost 58% of the total value while the remainder is accounted for by nonmarketed values. Across ecosystems, the most productive is the “other coastal” category, with 62% of the total at almost PhP 15 billion in 2006. This is followed by coral reefs, oceanic, mangroves and seagrasses. The contribution of the living coastal ecosystems – mangroves, seagrasses and coral reefs – is about a quarter of the total.

In terms of unit productivity, the highest is for mangroves, with coral reefs a distant second. Provisioning services is highest for seagrass beds while regulating services dominate in mangroves, coral reefs and other coastal ecosystems. For all ecosystems, however, the share of provisioning services exceeds that for regulating services by a small margin. These results show which type of service will be delivered by specific conservation management activities.

The analysis of the distribution of benefits from CMR shows that at least 66 percent of the benefits from all coastal ecosystems (mangroves, seagrass, coral reefs and other coastl) accrue locally. The global benefit is from carbon sequestration by mangrove forests. For coral reefs and other coastal ecosystems, local benefits also dominate due to their existence values. The regulating functions such as shoreline protection and waste assimilation are quite huge and contribute a large share to local benefits. For all ecosystems, over 65% of the total benefits accrue locally, almost 29% nationally and about 6% globally. The results show that impetus for coastal and marine conservation should be for the primarily benefit of the local (coastal) population and for the country as a whole. The proportion of global benefits is relatively small and covers specific goods and services.

The analysis of the costs of depletion and degradation of CMR provides an indicator of the extent of the damages to CMR according to source and by ecosystem. Total damages in 2006 alone reached almost PhP 5.7 billion, equivalent to about US$ 110 million. The biggest source of damages is from foregone fisheries production due to overfishing and habitat degradation, which contributed about PhP 2.6 billion or 45% of the total. Foregone benefits from coastal development accounted over PhP 2.3 billion (41%) while from pollution, the amount was about PhP 0.8 billion (13%). Damages from climate change are minimal as the only contributory factor is coral bleaching that happened in 1998. With potentially more frequent coral bleaching from climate change, the damages could increase exponentially. The stresses on the coastal and marine sector have affected primarily mangrove forests followed by coral reefs and other coastal areas at almost identical amount. The foregone net benefits per unit area (ha) are also presented in the table. The highest cost is registered for mangrove ecosystems at more than PhP 10,000 per ha while the figures for coral reefs and other ecosystems are much smaller. This shows that mangrove conservation would result in higher marginal benefits compared to other ecosystems.

Though not analyzed rigorously in this study, there are distributional impacts of environmental degradation. It could be inferred from the results that with the small-scale fishers and their families largely dependent on CMR for food and livelihood, the degradation of these resources would be most detrimental to this group. Their limited resource base would limit their coping mechanisms as their fishing vessels are not equipped to cover wider areas in search for fish. Gleaning along coastlines and intertidal areas, primarily done by women and children, would be susceptible overextraction and pollution. With limited opportunities for recreation, the poor are also affected as they come in contact with polluted coastal waters.

While gains have been made in managing CMR particularly in specific locations, the impacts of past inaction and mismanagement continue to take a toll in 2006. This is expected to be felt in the coming years as some of the stresses on the coastal zone are irreversible and in some instances, worsening. For instance, to a large extent mangrove conversion may be hard to convert back to mangroves except for unproductive fishponds. The indiscriminate disposal of household waste and wastewater discharges from industry into coastal areas is continuing as shown by the fact that no coastal and marine waters monitored by the DENR has improved in classification. On the contrary, 2 of the 41 marine areas monitored have deteriorated between 1996 and 2006. Initiatives to regulate municipal fisheries have been limited while there appears to be no real efforts to regulate commercial fishing.

However, there are positive developments from the data and the analysis in this study. The first is that mangrove forest cover increased to about 210,000 ha from the perennially reported 140,000 ha. The new information is based from the ground verification (almost completed as of early 2008) by

DENR-CMMO of area estimated by NAMRIA from satellite images. The increase could be attributed to the efforts of coastal communities supported by various donor organizations and institutions, including the government. Second is the increasing number of MPAs around the country. Although far from the overall target indicated in the PHILMARSAST, there is increasing recognition by local governments about the importance of protected areas in enhancing fisheries and generating livelihood from ecotourism. While most are still "paper" parks, the institution of effective management will further enhance benefits through better handle on threats. The third is the devolution of the control of municipal waters to local government units is a move in the right direction as resource beneficiaries become the stewards. However, its success is considered by the author to be still minimal as the necessary measures such as fisheries registration and licensing largely depends on political will.

Overall, this study is seen to provide an update of previous studies on the value of CMR while it provides new estimates of damages from the impacts of various stressors. It is recognized that the study is faced with a number of limitations, particularly with respect to the adequacy of local parameters. As new empirical studies are completed, the estimates may be updated and this study is recommended to go through subsequent iterations.

Interventions

Three interventions are proposed in this report and their costs and benefits are estimated to the extent possible. The interventions are those that can be undertaken within the coastal and marine sector which could be analyzed using the data presented in this report. It is emphasized that other stressors need to be addressed to optimize the benefits from CMR. These stressors include land-based pollution and climate change triggered by emissions of greenhouse gases that have negative impacts on the coastal zone. Human population management is also relevant but this is a much bigger and more controversial issue in the Philippine context.

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