Developments in Ecosystems, volume 1
Edited by M.H. Wong

Chapter 14

Wetland Conservation and Management in the Philippines: Where are We Now? The Case of Seagrass and Mangrove

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Abstract. A significant portion of the Philippine coastal habitats is at high risk of being lost in the next decade. Seagrass and mangrove ecosystems in the Philippines, known to be very productive and exhibiting high biodiversity, are under severe stress from the combined impacts of human overexploitation, habitat destruction, pollution, sedimentation and general neglect There is an urgent need to conserve and manage these habitats in the country in particular and in Southeast Asia in general. The reason for management of the coastal resources is that they are a huge natural and economic resource in the country in terms of food supply, livelihood, other revenue and quality of the environment.

To effectively conserve and manage Philippine seagrass and mangrove, we should: (1) focus research on priority management issues (link science to management); (2) develop an integrated framework for action; (3) undertake an economic valuation of the resources and of relevant policy changes; (4) forge public–private partnerships to manage, use, and conserve seagrass and mangrove; (5) ensure a functional coordination among concerned agencies; (6) increase the content of seagrass–mangrove repositories; and (7) for mangroves, adopt some "wise" management options. To protect the larger coastal and marine environment, governments should: (1) localize sustainable development through sound governance; (2) ensure high quality scientific publication (shift from description to synthesis); (3) position S and T centrally in economic development policy; and (4) adopt the Integrated Coastal Area Management philosophy.

14.1. Introduction

A significant portion of the Philippine coastal habitats is at high risk of being lost in the next decade. This is also true for the ASEAN region (Association of

DOI: 10.1016/S1572-7785(04)01014-7

Southeast Asian Nations comprising Brunei Darussalam, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam) where about half of its coastal resources have either been lost or are severely degraded during the past 56 years (Chou, 1994; Fortes & McManus, 1995; Fortes, 2001) and the rate of degradation is increasing. Human impacts are the primary cause for most of these losses and these are increasing as human populations increase. There is rapid economic and human population growth-over 80 million in the Philippines, with the population, just like in Southeast Asia, doubling in the next 25–35 years (World Resources Institute, 1990). Infrastructure development along coasts is doubling at almost decadal rates. People extract about 60% of the country's animal protein from the sea. These changes will result in greater demands for coastal zone resources, especially quality seafood products and space (Wilkinson, 2002). Our experiences in the past show that an explosive population growth coupled with rapidly dwindling resources will bring about short-term economic development mostly at the expense of the environment. The overall result of this potential loss of coastal resources are issues and concerns, which will farther aggravate the social and economic conditions of the greater portion of the region's population making ecological concerns serious socioeconomic issues. Today these issues bring about problems with far-reaching effects that go beyond sociopolitical boundaries.

There is an urgent need to conserve and manage seagrass and mangrove habitats in the Philippines in particular and in Southeast Asia in general. The reason we must manage our coastal resources is that they are a huge natural and economic resource in the country in terms of food supply, livelihood, other revenue and quality of the environment. Management, which implies wise use and maintenance of the resource, is crucial to ensure the continuous productive stream of net benefits without inputs from humans (White and Cruz-Trinidad, 2001). The problem in the Philippines simply is that we are damaging and overexploiting all the coastal ecosystems, compromising their natural productivity to the point of doing permanent damage to the entire system.

14.2. Status of Philippine Seagrass and Mangrove Habitats

Seagrass beds are estuarine or sea floor areas dominated by a discrete community of flowering plants. These plants are with roots and rhizomes (underground stems), thriving in slightly reducing sediments and normally exhibiting maximum biomass when completely submerged. With about 18 species in the Philippines, they grow best in estuaries and lagoons where they are often associated, physically and ecologically, with mangrove forests and coral reefs, often forming the ecotone between these two divergent ecosystems. Seagrass bed, as an ecotone, mediates the structural and dynamic components of the neighboring ecosystems via control of material, water, and energy flows between them. More importantly, seagrass systems support a rich diversity of species from adjacent systems and provide primary refugia for both economically and ecologically important organisms. As such, seagrass habitats are sensitive to fluctuations because species coming from their neighboring systems encounter "marginal conditions" and are at the extremes of their tolerance levels to environmental alterations. This sensitivity makes seagrasses useful indicators of changes not easily observable in either coral reef or mangrove forest.

A global picture of seagrass distribution has long been known (den Hartog, 1970). Related studies (e.g. Fortes, 1988; Mukai, 1990) augment our knowledge on seagrass biogeographical affinities. However, there are still wide areas where the existence of seagrasses likely remains unknown (Green & Short, 2003). A priority identified by the participants at the Global Seagrass Workshop (St. Petersburg, Florida, 9 November, 2001) was to come up with a map, which would provide the actual location and coverage of the world's seagrass habitats, incorporating their status in the face of environmental change. It is a partial result of an ongoing initiative of the United Nations Environment Programme-World Conservation Monitoring Center (UNEP-WCMC) to develop a comprehensive global GIS dataset coming from distribution maps from multiple sources.

Green and Short (2003) gives the most updated compilation of the seagrass flora of 115 countries and the current geographical distribution of the plants. The first of its kind for seagrasses, this points to three important findings: (1) the centers of diversity both at national and regional levels, with a clear focus in Southeast Asia reaching up to southern Japan, and a second focus of diversity in the Red Sea and East Africa; (2) some species have clearly restricted ranges; and (3) some species are endemic to single countries. Australia (31 species) and the Philippines (18 species) have the highest levels of diversity. The pattern reflects a high similarity with the global distribution of corals and mangroves. Interestingly, for seagrasses, this pattern extends farther north and into the temperate waters of Japan and show a much wider global distribution into cold temperate waters. It has been suggested that Southeast Asia may have been a center of species accumulation (the "vortex model of coral reef biogeography"), a region where, due to favorable climatic conditions in the recent ice-ages, species have converged ("vicariance hypothesis," McCoy & Heck, 1976), or a center for species evolution with the combination of benign conditions and changing sea levels ("eustatic diversity pump model").

Seagrasses play a significant role in global carbon and nutrient cycling. Although there is considerable variance on the productivity values reported for seagrasses worldwide, the values range from 500–4,000 g C $m^{-2}yr^{-2}$. This range ranks the plants among the world's highly productive ecosystems. The quantity of seagrass carbon available for storage in the sediments represent some 0.08 Pg C yr^{-1} (1 Pg = 10^{15} g) in the ocean as a whole (or 12% of the total carbon storage in the ocean despite its 1% contribution to the total oceanic production (Duarte & Cebrian, 1996). Although seagrasses only occupy a small fraction of the world's nearshore waters, and the total area of seagrasses is likely to be less than 10% of the shallow water area of the world's continental shelves (continental waters to a depth of 200 m, about 25 million km^2), they potentially could cover from 500,000–1,000,000 km^2.

Mangroves, on the other hand, is a type of forest growing along tidal mudflats and along shallow water coastal areas extending inland along rivers, streams and their tributaries where the water is generally brackish. Mangrove trees dominate the mangrove ecosystem as the primary producer interacting with associated aquatic fauna, social and physical factors of the coastal environment.

The Philippine mangrove flora consists of 47 true mangroves' and associated species belonging to 26 families (Melana & Gonzales, 1996). True mangroves grow in the mangrove environment; associated species may grow on other habitat types such s the beach forest and lowland areas. The mangrove fauna is made up of shore birds, some species of mammals, (monkeys, rats, etc), reptiles, mollusks, crustaceans, polychaetes, fishes and insects.

In the Philippines seagrass and mangrove ecosystems are two of the most productive and biologically diverse in the world. Table 1 shows the primary productivity of some of the major marine communities of the world. These ecosystems rank second and third in productivity, the basis of their economic and environmental roles in the region (Fortes, 1995a, 2001). With coral reefs, they are the major support ecosystems in Southeast Asia and the rest of the tropical world.

Table 1: Primary productivity of some major marine communities.

Community type	**Primary productivity (grams carbon/m^2/yr)**
Mangroves	430–5,000
Seagrass beds (only)	500–4,000
Algal and seagrass beds	900–4,650
Coral reefs	1,800–4,200
Estuaries	200–4,000
Upwelling zones	400–3,650
Continental shelf waters	100–600
Open ocean	2–400

Table 2: Primary producers of the oceans: estimates of area covered, total net primary production (NPP) and amount of this production consumed by herbivores, decomposed and stored.

Primary producer	Area (10^6 km^2)	Total NPP (Pg C yr^{-1})	Herbivory (Pg C yr^{-1})	Decomposition (Pg C yr^{-1})	Storage (Pg C yr^{-1})
Oceanic p-plankton	332	43	24.4	14.7	0.17
Coastal p-plankton	27	4.5	1.8	1.8	0.18
Microphytobenthos	6.8	0.34	0.15	0.09	0.02
Coral reef algae	0.6	0.6	0.18	0.45	0
Macroalgae	6.8	2.55	0.86	0.95	0.01
Seagrasses	0.6	0.49	0.09	0.25	0.08
Marsh plants	0.4	0.44	0.14	0.23	0.07
Mangroves	1.1	1.1	0.10	0.44	0.11
Total		5.3	27.8	19.00	0.65

After Duarte and Cebrian (1996).

Compared to the other primary producers of the sea, seagrasses and mangroves contribute substantially to the total oceanic production (Table 2). Note that despite the small contribution of seagrasses (1%) to the total oceanic production, it contributes 12% of the total carbon storage in the ocean (Duarte & Cebrian, 1996). The stored fraction accumulates in the system, as they are not decomposed within a year. On the other hand, mangroves account for 17% of the total marine CO_2 uptake. Worldwide seagrasses occupy an area of about 600,000 km^2 while mangroves occupy about 1,100,000 km^2 (Duarte & Cebrian, 1996).

14.3. Seagrass and Mangrove Biodiversity

A vast array of plants and animals live in seagrass beds and mangroves of the Philippines. This is due to the rich nutrient pool and diversity of physical structures protecting young marine life from predators. Fish and shrimp are probably the most important components of the habitats, although coastal villages in the country derive their sustenance from other components of the habitats.

Table 3 gives a comparison of species diversity among the major coastal ecosystems in the Philippines (modified from DENR/UNDP, 1997). Next to coral reefs, seagrass beds have the highest biodiversity. As in the whole of Southeast Asia, the figures may be grossly underestimated due to the paucity of documented information. There are indications largely through observations and ocular

Table 3: Comparison of species diversity among the major coastal ecosystems in the Philippines.

Taxon	Seagrass beds	Coral reefs	Soft bottoms	Mangroves
Seagrass	18	14	3	5
Algae	154	1,043	0	72
Corals	8	381	0	0
Other inverts	73	1,485	67	39
Fish	218	1,030	2	241
Mammals	1			
Reptiles	11	14		16
Total	483	3,967	72	373

Modified from DENR/UNDP (1997).

surveys, however, that the species richness in the habitats, particularly the fish and invertebrates, could be much higher than previously thought.

14.4. Threats to Seagrass and Mangrove

Seagrass and mangrove ecosystems in the Philippines are under severe stress from the combined impacts of human overexploitation, habitat destruction, pollution, sedimentation and general neglect (Chou, 1994; Fortes, 1995b). The resulting losses, expressed in thousands of dollars per year per km^2 of coastal area lost, have their greatest impact on local fishing communities and local tourism establishments. It has been estimated that the 27,000 km^2 of coral reefs and their associated seagrass beds in the Philippines, in their degraded condition in 1996, contributed a very conservative US$1.35 billion to the Philippine economy (White & Cruz-Trinidad, 2001). This figure includes values for fisheries, tourism and coastal protection analyzed in a similar manner to calculations by Cesar (1996) for Indonesian coral reefs.

In the last decade the coastal environmental issues perceived as exerting the most severe impact on the coastal and marine environment in Southeast Asia are given in Table 4.

After a decade the priority coastal environmental issues in the region remain basically the same even if the perception is carried over into the year 2020. An indication of this scenario resulted from a consultation with Philippine experts under the Global International Waters Assessment (GIWA) Project. Focused on five most important environmental concerns in Sulu-Celebes Seas, the result is shown in Table 5.

Table 4: Coastal environmental issues in Southeast Asia.

Issue	**Immediate**	**Short-term**	**Long-term**
Habitat destruction (*sm)	1	1	1
Sewage pollution (*sm)	2	2	3
Industrial pollution (*sm)	3	3	2
Fisheries overexploitation (*s)	4	4	6
Siltation/sedimentation (*s)	5	5	4
Oil pollution (*sm)	6	6	8
Hazardous waste	7	7	7
Agricultural pollution (*s)	8	8	5
Red tides (*s)	9	9	11
Coastal erosion (*sm)	10	10	10
Natural hazards (*sm)	11	12	12
Sea level rise	12	11	9

These issues are ranked in order of priority and classified into urgency categories, i.e. immediate, short-term or within the next five years, and long-term or within the next 10 years or more. Those with asterisks are identified with severe negative impacts on seagrasses (*s) or mangroves (*m) or both (*sm). Modified from UNEP (1990).

Table 5: Five priority coastal environmental issues in SE Asia, categorized on the basis of severity and rank.

Environmental concerns	**2001**		**2020**	
	Severity	**Rank**	**Severity**	**Rank**
Habitat and community modifications (*sm)	3	1	3	1
Unsustainable exploitation of fisheries and other living resources (*sm)	3	1	3	2
Pollution (*sm)	2	3	3	2
Freshwater shortage (*m)	2	4	3	4
Global change	1	5	1	5

Severity: 3, most severe impact, 1, slight impact; Rank: 1, highest, 5, lowest. Those with asterisks are identified with severe negative impacts on seagrasses (*s) or mangroves (*m) or both (*sm).

14.5. Worldwide Decline

Worldwide, there has been a rapidly increasing intensity of seagrass loss and decline (Thayer et al., 1975) and in many cases the magnitude of loss is high. In Asia-Pacific decline in seagrasses are well documented for 10 sites (25% of the total number of areas where declines have been reported (Short & Wyllie-Echeveria, 1996). These are confined in the following areas (Table 6).

In Southeast Asia, seagrasses are under threat from loss of mangroves which act as a "filter" for sediment from land, coastal development, urban expansion and bucket dredging for tin (Lean et al., 1990). Other impacts include, substrate disturbance, industrial and agricultural runoff, industrial wastes and sewage discharges. At the Seagrass Workshop held in Bangkok in December 1993, seagrass scientists of the ASEAN-Australia Living Coastal Resources (LCR) project have indicated that seagrass habitats in East Asia are rapidly being destroyed. In Indonesia about 30–40% of the seagrass beds have been lost in the last 50 years, with as much as 60% being destroyed around Java, while in Singapore, the patchy seagrass habitats have suffered severe damage largely through burial under landfill operations. In Thailand, losses of the beds amount to about 20–30%. Very little information on seagrass loss is available from Malaysia. In the Philippines, seagrass loss amounts to about 30–50%.

Table 6: Some countries and areas in Asia-Pacific with documented seagrass declines.

Country/region	**Area lost km^2 (%)**	**Cause(s)**	**Source**
Gulf of Carpentaria, Australia	150 (82%)	Cyclone	Poiner et al. (1989)
Hervey Bay, NE Australia	1,000	2 Floods + cyclone	Preen et al. (1995)
Botany Bay, Australia	Unknown	Dredging, explosion of sea urchin population	Larkum & West (1990)
Cockburn Sound, Australia	(80%)	Eutrophication from industrial development	Cambridge & McComb (1984)
Indonesia	(30–40%)	Siltation, pollution	Martosobroto (1994)
Philippines	(30–50%)	Siltation, eutrophication, unsustainable fishing	Fortes (1988)
Thailand	(20–30%)	Pollution, siltation	Sudara et al. (1994)
"World-wide"	12,000	(Unspecified)	Short & Wyllie-Echeverria (1996, 2000)

Table 7: Mangrove areas in Asia-Pacific and the margin threats.

Country	**Area (km^2)**	**Remarks**
Brunei Darussalam	70	Some portions lost to coastal development
Cambodia	100	Greater portion degraded via siltation
Indonesia	42,500	3,000 km^2 lost to coastal development
Malaysia	6,500	Vast areas lost to shrimp ponds
Philippines	1,320	Vast areas lost to shrimp/fishponds
Thailand	1,960	Vast areas lost to shrimp ponds
Vietnam	2,000	Decreased by about 45% since 1945
Pacific Islands	1,460	Vast areas lost to land clearing, agricultural development

Pacific Islands comprise Melanesia, Micronesia, Polynesia, Australia, and New Zealand.

In addition to the traditional uses of mangroves which, by and large, were fairly sustainable, recent population and economic pressures have led to an over-exploitation of the trees themselves as well as the conversions of the wetlands they occupy (ESCAP and ADB, 1995). Mangrove woods is being harvested for making charcoal (which in some cases is being exported); as a direct source of firewood; for the production of poles and other construction timbers; for the extraction of tannin used in the manufacture of inks, plastic and glue; and, for producing wood chips which are used as raw materials for the production of rayon (Aksornkoae, 1993). The vast area of mangrove forests in Asia-Pacific is partly shown in Table 7.

The rate of mangrove denudation in the Philippines is shown in Fig. 1. Thus, from 1918 to 1970, an average of 3,100 ha of mangroves were lost every year, increasing to about 8,200 ha annually from 1970 to 1988. The loss was due mainly to conversion to fishponds during the 1960s and 1970s. At present, 95% of the remaining mangroves are secondary growth and only 5% are old or primary which are mostly found in Palawan.

14.6. Monetary Value of Seagrass and Mangrove

The 27,000 km^2 of coral reef and seagrass ecosystems in the Philippines, equal to slightly more than 10% of the total land area of the country, are of significant value in terms of fisheries for food security, coastal protection, tourism, education, research and aesthetic value (Gomez et al., 1994; White, 1987; Courtney et al.,

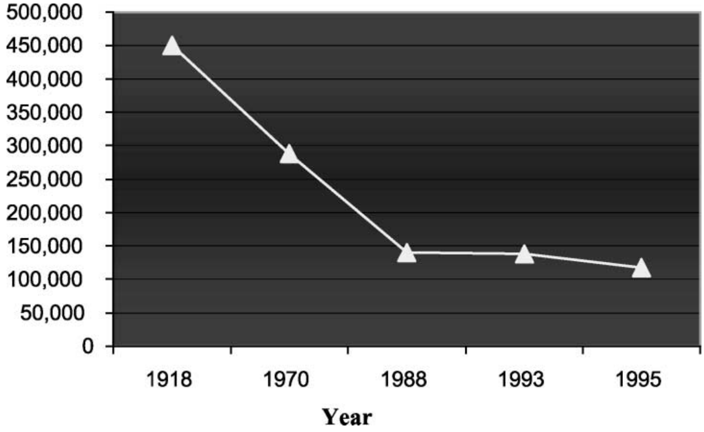

Figure 1: Mangrove denudation in the Philippines: 1918–1995.

1999). Most of the major commercial fisheries of ASEAN occur immediately adjacent to seagrass beds (Fortes et al., 1994). These beds are particularly important as nursery and feeding grounds for much of the sub-region's prawn and fish catch (Poovachiranon et al., 1994). In the Philippines, coral reefs with their associated seagrasses potentially could supply more than 20% of the fish catch (McManus, 1988). A total of 1,384 individuals and 55 species from 25 fish families were identified from five seagrass sites in the country. All members of these families have economic value mostly as food and aquarium specimens. Five times as many fish live over seagrass beds as over sea floors made up of mud, shells, and sand (Lean et al., 1990).

But there have been very few studies of the direct economic benefit humans derive from seagrasses. It has been estimated that the economic return from seagrass beds can be up to US$ 86,000 per acre (IUCN/UNEP, 1984). Based primarily on the fisheries they support, seagrass beds in Cairns, Australia, cost A$700,000 annually (Coles, 1986). Watson et al. (1993) found that the potential total annual yield from Cairns Harbor seagrasses for three major commercial prawn species was 178 t yr^{-1} with a landed value of US$12,325 annually. In Monroe County, Florida, the commercial fishery for five seagrass-dependent species was estimated at US$48.7 million yr^{-1}. Worldwide, recreational fisheries, diving and snorkeling are industries, which depend directly or indirectly upon healthy seagrasses beds (Heck, 2001). In an assessment of the economic value of the world's ecosystems, Coztanza et al. (1997) listed the value of the nutrient cycling function of seagrass beds at US$3.8 Trillion, the second highest among all the other ecosystem values listed. Estuaries ranks first, but again, seagrasses are often found in these habitats.

In the case of mangrove in Bacuit Bay, western Philippines, an economic analysis was made to examine the economic effects of sedimentation pollution on tourism and marine fisheries based on two development options: (1) to ban logging in the bay's watershed; and (2) to allow logging to continue as planned (Hodgson & Dixon, 1988). The results of the study are striking. The project estimated a reduction in gross revenue of more than US$40 million over a 10-year period with continued logging of the Bacuit Bay watershed as compared with gross revenue given implementation of a logging ban. The difference is due to projected losses from tourism and fisheries.

An estimated net annual economic value (in US$/ha) of Philippine mangrove areas for different levels of management is given in Table 8 (White & Cruz-Trinidad, 2001).

The total gain to the Philippines for protecting its remaining mangrove ecosystem is substantial. Using the conservative estimate of value from direct benefits of only US$600/ha/yr, the country gains at least US$83 million/yr in fish production and potential sustainable wood harvest from the existing 138,000 ha. If we could increase the area of healthy mangrove forest to 200,000 ha, the annual natural benefits would potentially increase to US$120 million for a gain of about US$37 million/yr.

In the Gulf of Fonseca in El Salvador, three different management strategies for mangroves were considered (Gammage et al., CSI Forum): partial conversion to semi-intensive shrimp farming and salt production; the do-nothing strategy of deforestation, land clearance and degradation; and the sustainable management option. A variety of different valuation techniques were used to assess the contribution of different products and services of the mangrove ecosystem. The sustainable management strategy enables more timber and fisheries benefits to be captured over a longer time frame than do the other management options.

Table 8: Estimated net annual economic value of wood and fish products from Philippine mangrove areas under different levels of management.

Level of management	**Wood products**	**Fish products**	**Total**
Mangrove plantation	156	538	694
Managed naturally regenerated	90	538	628
Unmanaged under stocked stands	42	538	580

Note: Wood harvest value based on average price of about US$12/cu m of wood; fish products based on average annual weight of fish and shrimp/ha associated with mangrove areas and an average price of US$0.80/kg; values based on Philippine Pesos, US$1 = PhP 25 in 1991.

Both the current management strategy and the partial conversion strategy yield net benefits of approximately US$7,500 per hectare whereas the sustainable management strategy generates a little over US$10,000 per hectare in ecosystem goods and services. The benefits from sustainable mangrove management can only be captured if existing patterns of resource use are modified. This requires fundamental changes in existing policy and legislation and in the institutions that administer and enforce these laws. Costanza et al. (1997) has provided new estimates of the services derived from mangrove ecosystems (e.g. shoreline protection, protection against rising seas, food and wood production, and habitat for wildlife) at US$10,000/ha/yr.

14.7. Impediments to Addressing the Issues

A review of seagrass literature produced over the past decade (1989–1997) showed a sustained increase in the scientific production in international journals. In addition the annual publication rate doubles every four years. Led by Western Europe, the Mediterranean, Caribbean and Australia, 33 countries have contributed to the knowledge base. Similar efforts in Northwest America and Southeast Asia are notably encouraging. However, scientists from only two countries produce half of the production, the focus of study on only 10% of the seagrass flora from only two biogeographic areas. In addition these studies are largely descriptive (>60% of papers), not synthetic, hence, with low predictive value useful to resource management.

Coordination in global seagrass research is extremely limited and fragmented, resulting in great uncertainties when scaling up the knowledge produced locally, so that broad-scale assessment of seagrasses is faced with great difficulty.

The sad state of research on seagrasses and mangroves is a reflection of the dismal state of marine science worldwide. In Asia-Pacific the latter has been confronted with the greatest barrier to its development and diffusion: the lack of effective linkages between science institutions (scientific production) and the productive sector (application). With it comes the other obstacles which, in the next century, would still be the shortage of funds for research, low salaries for staff, lack of access to needed technologies, weak technical support infrastructures, poor public appreciation of coastal resources and environment, and the relatively small number of researchers trained in promoting an integrated management approach. Unless there is a substantial change in the legislative agenda within the majority of developing Asia-Pacific countries especially in Southeast Asia, the lack of national commitments to support and encourage the development of marine science with focus on coastal resources management and protection will remain a major deterrent.

Until very recently efforts to manage the coastal and marine environment in the Philippines have focused mainly on identifying the problems and planning remedial and preventive measures. Past and increased awareness of the problems in the country have therefore not actually solved the problems that the marine and the coastal environment face. However, renewed attempts are being made at the national, regional and international level to address the problem effectively. On the other hand, countries of the region have joined various international and regional agreements to resolve the problem and yet huge tracts of seagrass beds and mangroves are increasingly being degraded and lost, and species depending upon them for survival, threatened. This is in part due to the fact that policy or decision makers are unaware of the features and values of these wetlands in their charge. While there is a large amount of knowledge on the threats to the habitats, this has not been placed in context, making it difficult to use to assess the state of global seagrass and mangrove resources or to establish priorities for their management With increasing pressures from population growth, the rising number of megacities, accelerated economic development, depletion of coastal resources, degrading of coastal water quality and increasing resource use conflicts, there is a critical and urgent need to move from information gathering and planning to management solutions of coastal and marine environmental problems.

In addition to the inadequacy and ineffectiveness of efforts to conserve and manage seagrass and mangrove habitats, functional coordination among the stakeholders is nowhere in sight. Depicted in Fig. 2 below, this is the biggest impediment to success in coastal habitat protection.

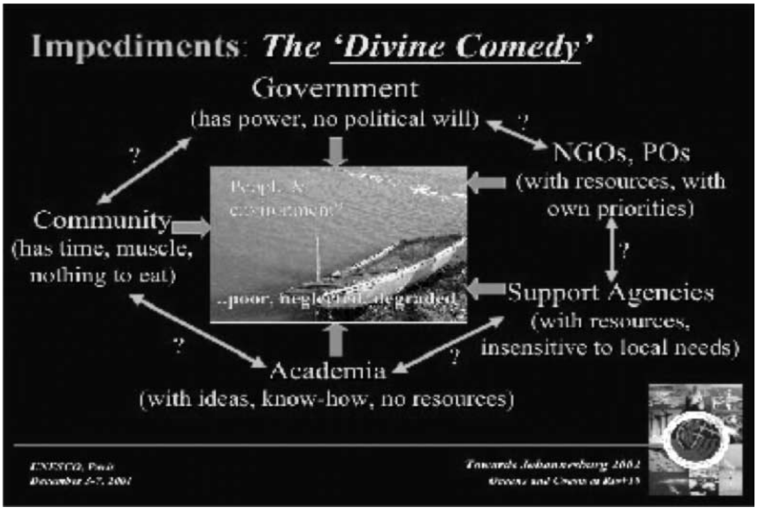

Figure 2: Lack of political will and non-coordination among agencies: the biggest impediments to success in coastal habitat protection.

14.8. Conservation and Management Strategies

This section of the chapter contains some recommendations or steps to be undertaken in order to arrest coastal habitat destruction in the Philippines. They are given under two categories: those specific for seagrasses and mangrove habitats and those for the protection and management of the country's coasts as a whole. Central to the formulation and implementation of these recommendations are conditions, which should be adhered to in order to ensure positive feedback from the people. These include: adherence to rules and regulations; participatory in character; built on consensus; incorporates capacity building and institutional strengthening; gender sensitive, and with regional and global perspective.

14.8.1. For the Management of Seagrass and Mangrove Resources

Focus Research on Priority Management Issues. In the last 5 years the Philippines (with Thailand and Vietnam) has seen remarkable efforts in understanding seagrasses and mangroves and utilizing research data and information to bring about a positive change in approaches to reverse the degradation and loss of these habitats. Funding agencies like the European Union have become more receptive to the clamor to understand the responses of these plant communities to siltation derived from deforestation (Project TS3*-CT94-0301 of the STD-3 programme of the European Commission). The percent sediment yield from Southeast Asian rivers to the ocean is the largest on earth (Milliman & Meade, 1983), hence, siltation remains the priority coastal environmental problem in the region. The significant output of the project has been a basis for another, more focused research initiative to predict their resilience and recovery given Southeast Asia's coastal environmental conditions (EU Project INCO-DC Contract No. ERBIC18CT980292). In many countries in the region, mangrove reforestation and afforestation have been enhanced to improve the productivity and protective capacity of coasts. The increased awareness on the important role seagrasses and mangroves play in the conservation of coastal biodiversity have prompted NGOs to contribute significant efforts and resources in understanding these plant communities and protecting them to conserve endangered species like dugongs and turtles. The documented loss of seagrass habitats has prompted concern among managers and scientists to search for indicators of seagrass ecosystem health. In the Philippines experimental approaches, based on the work of Fonseca et al. (1982), have been revitalized to investigate the potential of seagrass (natural and artificial) to restore or rehabilitate degraded coastal areas (e.g. mine tailings disposal sites).

Remote sensing has been used in the region on a pilot project basis to obtain data on suspended sediments in the water column, topography, bathymetry, sea state, water color, chlorophyll-a, sea-surface temperature, fisheries, oil slicks, and submerged and emergent vegetation, including mangroves and seagrass meadows (Kam et al., 1992). However, despite its undoubted potential, remote sensing has some severe limitations and practical problems when applied to the coastal zone in particular, which arises primarily from tidal water level fluctuation which influences the level of penetration. A further constraint to the use of remote sensing, particularly the use of satellite imagery, in the coastal zone of the tropics and sub-tropics are their propensity for cloud cover, which hinders the taking of images. In spite of these difficulties, remote sensing is an appropriate method for addressing information needs in coastal decision-making and it is therefore surprising that in the Asian and Pacific Region, remote sensing has not been integrated into national coastal development processes (Kam et al., 1992).

Complementing remotely sensed images of the coasts, there is an urgent need for basic and directed research the results of which are contained within an integrated information management system that can be used to monitor the rate of change of Philippine wetland resources, and a need to make it available for planners of seagrass and mangrove conservation.

There is a dearth of data on the current status of the seagrasses and mangroves in the Philippines: their actual overall coverage, density, growth patterns, their responses to perturbations, and use patterns. Similarly, almost no data exist on fuel wood and timber requirements, siltation, pollution, and chemical runoff into rivers and water bodies that drain into the mangroves. The data that exist are scattered and inconclusive and do not provide sufficient detail for the development of parameters to guide and monitor the sustainable extraction of seagrass and mangrove resources. In order to work towards more sustainable seagrass and mangrove management in the Philippines, key gaps in data collection need to be addressed. Data need to be collected on key biological and human-environment indicators that will guide policy and set parameters for sustainable resource use. The regions in the world where large-scale seagrass declines have been recorded should convince international and national governments of these regions to focus more integrated research efforts on these critical areas.

Interestingly, Fig. 3 gives a picture, in terms of publications, of the progress made in seagrass and mangrove research in Southeast Asia from 1985 to 2001. In part it also reflects the available expertise on seagrasses in the region. It can be seen that while the trends in the studies remained basically similar, those in mangroves have been undertaken with more vigor than seagrasses. This is primarily due to the relatively young state of seagrass science in most parts of the region. One reason for the slump in the production of published works from 1985 to the 1990s had been associated with the dramatic decline in the economies in

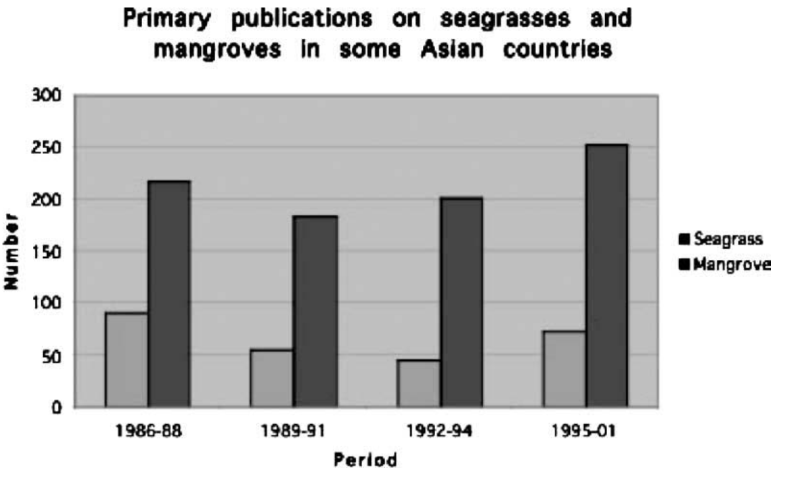

Figure 3: Publications on seagrass and mangroves in Southeast Asia from 1985 to 2001.

many parts of the region. This brought about the increased involvement of scientists in technical services (consultancies) where their outputs were merely published in grey literature. The renewed interest in quality outputs in 1994 reflects the impetus both academic institutions and funding agencies placed on marine science despite a continued decline in economic conditions.

Develop an Integrated Framework for Action: Putting Our Acts Together. For seagrasses the International Seagrass Biology Workshop series have produced the essential elements in conserving and sustainably utilizing the seagrass resources of the world. These elements consists of: (1) the needed linkages among seagrass scientists and practitioners from all parts of the world; (2) the mechanisms to ensure access and transmission of data and information; (3) sustained research activities on the dynamics of the ecosystem; and (4) modest support from academic and funding institutions. With support from UNESCO–IOC the association initiated the establishment of the World Seagrass Association (WSA). With the help of the French and Italian Governments, the association now serves as the clearinghouse of all activities on seagrasses in the world. At the time of its establishment, the Seagrass Monitoring Project (*Seagrass* Mon) and Seagrass Network (*Seagrass* Net) were developed and operationalized to implement the plan of action for seagrasses. Approved at the third International Seagrass Biology Workshop in the Philippines (1998), the *Charter for Seagrasses* was adopted, laying the principles that guide research and development of seagrasses in the world.

In the case of mangroves, a coalition of community groups, researchers, non-governmental, private sector, and governmental agencies in Honduras and El Salvador has developed a platform for action for the sustainable management of the mangroves in the Gulf of Fonseca (Gammage et al., http://www.unesco.org/csi/wise/fonseca1.htm). The platform for action has been developed as an advocacy tool for activists, NGOs and community groups to allow these organizations to engage in dialogue with both the government and the private sector. It represents the outcome of more than eight years of collaborative activities to explore the competing interests for mangrove resources of community groups, aquaculturists, farmers, salt producers and fisher people. The platform advocates for legislative, institutional and procedural changes to be set in motion to begin to harmonize the diverse interests of these multiple stakeholders in the ecosystem. The recommendations provide guidelines for a process that must be set in motion if these unique resources are to be preserved. It is essential that policies and programmes are devised that can simultaneously meet development goals and guarantee the health and well being of the ecosystem. Without such efforts, the mangroves will be degraded and a wealth of resources that they secure will be lost.

As in the United States a coastal initiative tasked to codify information needs in different regions should be developed. A knowledge base can then be used to formulate local, regional, and national conservation strategies for seagrasses and mangroves that are biologically and ecologically acceptable and economically sustainable. The goal of these strategies should be net enhancement of natural capital for the sustainable use by present and future generations. These strategies should include mechanisms for managing and protecting the ecosystems sustainably in the face of global change; they should also employ the best, most up-to-date scientific information available, and should evolve to incorporate new information as it is generated. A periodic review will have to be designed to answer among others, the following questions: Is the scientific information being used actually relevant to the policies and decisions that must be made? Has information been provided in a way that facilitates its use? Is the information timely? Is it credible? Do decision makers understand it? Do stakeholders understand it?

The initiatives above are currently seeking more support to continue their worthy scientific and advocacy campaign and hope to develop a series of popular education materials, radio and television advertisements that address the concerns raised in the platform for action and provide targeted information to a range of parliamentarians and municipal officials in coastal districts.

Undertake an Economic Valuation of the Resources and of Relevant Policy Changes. In the past many environmental problems were regarded as local and straightforward. They were seen as being easily regulated by elementary command-and-control instruments. Now, more environmental problems have come to be recognized as having greater complexity than previously thought, with wider impacts than first-round or local effects. This gave rise to market-based approaches to environmental regulation.

As mentioned above seagrasses and mangroves provide environmental goods and services. In most parts of the developing countries of Asia-Pacific, however, these are being used unsustainably without regard to the external costs that their actions impose upon the ecosystems and upon others who also depend upon them. The "total economic value" of seagrass and mangrove ecosystems should be estimated using a cost-benefit analysis to compare the sustainable management of the habitats with alternative use scenarios.

Market mechanisms will only be successful if they reflect the preferences of citizens as individuals, both nationally and internationally. Environmental economics has made considerable progress over the last half century in devising methods that attempt to quantify the strength of preferences for various environmental amenities, and to identify and define the extent of the market (people) affected by environmental changes. Environmental valuation of the resources and the benefits of policy change relative to these resources are thus extremely important. It should be emphasized, however, that in the process we face the dilemma of pricing the priceless, of quantifying the unquantifiable, of creating common standards for things apparently unequatable (de Groot, 1992). Fonseca (personal communication) argued that trying to determine the monetary value of an obviously rich and biologically diverse resource as a seagrass ecosystem might be a waste of time, for this will only further delay its development. But until better instruments and methodologies are found, giving money values to ecosystem functions may help convince policy makers and financiers of development projects of the importance of nature conservation and the true meaning of environmentally sustainable economic development. In the valuation process, however, ecologists should be involved more actively with the view that the whole exercise is purely for the purpose of management. This is because if they are not, others who are less informed of the true worth of the environment eventually will, and attach to it a much lower price. The low values attached to coastal resources are one principal reason for their continued loss.

Forge Public–Private Partnerships to Conserve and Manage Seagrass and Mangrove. In order to conserve and manage seagrass and mangrove resources sustainably, it is necessary to use the relevant scientific information that is currently available. It should inform conservation strategies at the local, regional, and national levels. It is also necessary to generate new knowledge to fill in gaps in our understanding of the ecosystems in the face of environmental change. Hence, we should start by using the knowledge that we do have, organizing it electronically, and providing it to all parties that need it. To accomplish this, we will need to form partnerships among governmental organizations at international, regional, national and local levels, and between them and the private sector. These partnerships, using up-to-date information, can begin the process of developing coordinated strategies by designing best management practices and further sharing information.

The Workshop, *Seagrass-Watch: Community, Coasts and Clean Seas* held in Hervey Bay, Brisbane (12–15 October 2001), is a commendable effort on the part of Queensland Department of Primary Industry to increase people's awareness on the importance of seagrass resources. The workshop discussed various approaches to involving community groups in seagrass monitoring and research and/or the wider question of the role of communities in science and in decision-making.

Ensure a Functional Coordination Among Concerned Agencies. Coordination of actions among various agencies mandated to protect the coasts would help to eliminate duplication of effort and therefore save funds that could be invested more wisely. Coordination also would illuminate research areas in which agencies and academia could cooperate, and would facilitate the development of information systems that would serve not only management agencies but also the public. The coordination process should provide forums for discussion, so that lessons learned by one entity can be instructive to many. At present, the region is probably not gaining the full value of lessons learned from policy successes and failures. Forums also provide an avenue for input from the public and from the private sector, which in itself can be of great value in time and expense saved, opportunities for understanding gained, and in litigation avoided.

The absence of coordinated strategies for conservation is one factor that allows the continued degradation of the region's natural coastal capital. If coordination of management and research activities is not achieved, many of these agencies will continue to manage inefficiently or to work at cross purposes with each other. This in turn leads to unnecessary expenditures, interagency conflict, public dissatisfaction, and mismanaged natural resources. In the absence of coherent strategies, it will become more and more difficult to bring the results of up-to-date research into management and policy decisions.

Increase the Content of Seagrass–Mangrove Information Repositories. At present the amount of information that any repository of knowledge on seagrass and mangrove ecosystems in the Philippines and Asia-Pacific can provide does not reflect even a small percentage of the body of ecological and other biological knowledge. There is much information available in the scientific literature and even in databases that is not part of any of these structures and is not readily accessible, but which could be extremely useful in the generation of habitat conservation plans and other ecosystem management strategies. Steps should be taken to increase the online electronic information content of these data repositories via the allocation of a certain percentage of all research funding specifically for the long-term management of the data and information generated.

Adopt "Wise" Management Options. True management of seagrasses resources is in its infancy in the Philippines. On the other hand, years of experience characterize local efforts in conserving and managing mangrove resources in the country. These point to four options, which have the highest probability towards a successful management of the habitat. These are:

1. Mangrove nursery establishment and management-site selection, design, operation and management of nurseries for the Philippine mangrove species. Nursery technologies ensure the availability of planting materials and the production of high quality seedlings.
2. Mangrove plantation establishment and management-developing and managing mangrove plantations and the remaining natural forest stand to maximize the benefit to the coastal ecosystem; non-regulatory techniques (training and education, research and monitoring) are especially relevant strategies in mangrove plantation planning.
3. Community-based forest management agreement (CBFMA)-a production sharing agreement entered into between a community and the government to develop, utilize, manage, and conserve a specific portion of the forestland, consistent with the principles of sustainable development pursuant to a community Resource Management Framework (CRMF). The latter is a document that defines the terms and procedures for accessing, using and protecting natural resources within the CBFMA.
4. Fishpond restoration-modifying abandoned or illegal fishponds in CBFMA areas to harvest firewood, poles, shells, fish, crabs and to provide food and shelter to crabs, shrimp, shells and fish in coastal waters. Aquasilviculture, which is the conversion of a fishpond area into a site where mangroves can grow and fish can thrive, is suggested as a fishpond restoration strategy.

14.8.2. For the Protection of the Larger Coastal and Marine Environment

Localize Sustainable Development Through Sound Governance. Given the largely similar and specific operational and field conditions among the coastal communities in the Philippines and the difficulty in translating experiences from other parts, more effort should be invested to encourage the exchange of experiences and successful examples and models among these states and regions.

However, this initiative should not detract from the value of cooperation and twinning with countries from other parts of the world.

Management programmes for coastal regions and small islands must be based on the interests of all stakeholders, and should not be exclusively top-down or bottom-up orientated. Universities, NGOs and agencies must work together to develop an action research agenda, which supports sustainable income-generating activities.

The issues confronting the coastal and marine environment can be effectively addressed by adopting certain innovative measures, which start with general recommended strategies and thereafter focusing on certain specific objectives that uphold these strategies. The latter include: crystallizing the people's vision for coastal marine ecosystem development; providing and exercising political will, dynamic leadership and the courage and determination to pursue this vision; and getting the people, government, and all sectors (private plus donors) to support this vision. The major objectives are envisioned to guide the environment sector in the performance of its evolving role in leading the implementation and enforcement of laws and regulations.

In the Philippines, the environment sector of the government is perceived as an "unfriendly" entity whose personnel are the first to violate the laws they are mandated to uphold. Its policy programs are heavy on addressing the "victims," not the "culprits." This is one major reason for the general distrust and non-confidence people have on the government. What people wants now is for the sector to work by example, demonstrating with honesty and a low profile, what it can do and cannot do, its successes and failures. The latter has been difficult because in most cases, activities have been practically monopolized by the sector, not involving the people in the process. Many that see it if only the sector could effectively enforce the laws, at the same time help educate the people; at least half of the problems would be solved.

Ensure High Quality Scientific Publication: A Shift from Description to Synthesis. The problems of insufficient information arising from the low priority nations in the region accord marine research and the poor quality, largely descriptive, data available are reflected in the share Third World countries have in the so-called international scientific literature. Although developing countries encompass 24.1% of the world's scientists and 5.3% of its research spending, most leading journals publish far smaller proportions of articles by authors from these regions (Gibbs, 1995). This is shown in Table 9.

This near invisibility of less developed nations in international scientific literature may reflect the economics and biases of science publishing as much as the actual reality of Third World research. Such invisibility to which mainstream science publishing condemns Third World research, however, thwarts the efforts

Table 9: Share of mainstream journal articles.

Country	% of total for all nations
USA	30.817
Japan	8.244
UK	7.924
France	5.653
Canada	4.302
Taiwan	0.805
Hong Kong	0.205
Singapore	0.197
Thailand	0.086
Malaysia	0.064
Philippines	0.035
Indonesia	0.012
Cambodia, Laos, Vietnam	0.006

Only the top five countries and 10 from Southeast Asia are shown (after Gibbs, 1995). Data are taken from papers published in 1994 by some 3,300 journals included in the Science Citation Index, a commercial database.

of poor countries to strengthen their indigenous science journals -and with them the quality of research in regions that need it most. It may also deprive the industrial world of critical knowledge. As Christopher T. Zielinski of the World Health Organization puts it, "The 2% participation in international scientific discourse allowed by Western indexing services is simply too little to account for the scientific output of 80% of the world."

In Ecology, *Trends in Ecology and Evolution* is a top reputable journal. But in 1994, it accepted no article for publication by authors from any of 100 developing countries. The low representation accurately reflects the poor quality of science in poor countries: "Environmental Science in developing countries is indeed lagging behind the rest of the world, just as you would expect," says, William H. Glaze, editor of Environmental Science and Technology. "Not only is it old-fashioned, but sometimes it is just not very well done. The documentation is poor, and the experimentation does not meet our standards."

In coastal zone management this "trend" is similarly reflected. There are indications of use of generally poor quality, largely descriptive, hence, with low reliability information (represented by "gray" literature). This is demonstrated in Table 10 (after Lacanilao, 1995).

Table 10: Publications in Coastal Zone Management with "good"- and "poor"-quality information.

	Total articles cited	**No. from refereed journals[a]**
MPB 26:540, 1993. Environmental impact Assessment — a review of its aims and recent developments	36	30
East-West Centre SPREP Training Manual, 1989. How to assess environmental impacts on tropical islands and coastal areas	102	4

[a] Journals covered by indexes of the Institute for Scientific Information

One implication is that high-quality reliable ecological knowledge (quantitative studies, published in refereed journals) is not or only peripherally utilized as guides in the management process. It also implies our inability to access valuable information much needed in coastal zone management. For example, a major reason why marine conservation lags behind terrestrial conservation is our ignorance of the sea's vulnerability to us, which we can only understand largely through ecological research. We know less than we need to, and the little knowledge that is available of traditional users of the sea and marine ecologists is not available to all who need it. This is the reason why we lack broadly applicable marine ecological theory. Most countries in the region lack even basic background information of currents, species inventories, and especially ecosystem dynamics that are fundamental to informed decision-making. This lack of knowledge prevents coastal managers from using a simple set of standards to guide all their decisions. Because so many decisions are based on incomplete information, how decision-makers rule when there is insufficient knowledge is a central question in coastal zone management. Its answer will determine whether sustainable use becomes a living, working reality or a fondly disregarded concept having no relevance to the world in which we live.

***Position Science and Technology Centrally in Economic Development Policy*.** Along with changing regional and economic structures, the Philippines sought to position science and technology (S and T) more centrally in its programs for economic development. Production and trade in the western Pacific Rim countries in the latter part of the decade reflect a regional economic identity with science at the core of each development strategy. There is a general drive to orient science in the public sector towards the marketplace and to look for future S and T growth and application within the business sector.

There are considerable variations in the level of industrial development among Asia–Pacific nations. More importantly, this condition is invariably correlated with the status of S and T links between sectors. Science across the region is now more context-oriented and focused on the research problems articulated by the private sector. Driven both by the growth in the business and university sectors and by government policy, alliances between scientific institutions and business enterprises have multiplied. A recent Asia Pacific Economic Cooperation (APEC) study identified keener competitiveness, greater complexity of knowledge, the pace of technological advances, and increasing financial pressures on universities as being among the major factors combining to drive sustained growth in university-industry collaboration.

Most countries of the region have recorded a rise in gross domestic expenditure on R and D (GERD) in the 1990s. This is shown in Table 11. In absolute terms, GERD has increased steadily across the region, but because of the rapid and sustained growth of GDP in economies like Singapore, the ratio of GERD to GDP has not always improved. In the case of China, it has actually

Table 11: GERD in Selected Pacific Rim Economies as a Percentage of GDP Germany and the USA are given for comparative purposes.

	1981	**1991**	**1995**
Australia	1.0	1.3	1.6
China	0.8	0.7	0.5
Indonesia	–	0.2	0.3
Japan	2.3	3.0	3.0
Republic of Korea	0.6	1.9	2.4
Malaysia	–	0.8	0.4
New Zealand	1.0	0.9	1.0
Philippines	–	0.2	0.2
Singapore	0.3	1.3	1.2
Chinese Taipei	0.9	1.7	–
Thailand	0.02	0.2	–
Germany	2.4	2.7	2.3
USA	2.4	2.8	2.5

Source: S and T Analysis Section, Department of Industry, Science and Technology, Australia (1996), based on OECD and national data.

fallen. Notwithstanding the fact that accelerated economic growth has sometimes masked increases in real R and D expenditure, recent estimates suggest that by 2005 the East Asian economies alone will spend more on R and D than the USA (Table 11).

The Medium Term Programme for S and T in the ASEAN for 1996–2000 focuses on developing a technology information network to link institutions and existing networks and thereby promote information sharing, human resource development, and technology transfer in the rapidly developing technology-intensive business environment. A first step in this direction was the establishment in 1996 of the ASEAN Science and Technology Management Information System (ASTMIS).

With respect to the small Pacific Island countries, what they have in common is that their economic growth has been stagnant to low since the 1980s, that their indigenous communities are largely subsistence-based. However, most have prospects for significant industrialization. Scientific research has been mainly a public sector activity concentrating on natural resource utilization. Stagnant economic growth, alongside high population growth and the resultant boom in unemployed youth, has sharpened awareness on the need for alternative development paths. Here, scientists have increasingly focused on meeting people's needs through participatory R and D, spearheaded by several NGOs. This necessitates examining what people know and do, including investigating traditional knowledge and technologies.

Adopt the Integrated Coastal Area Management Philosophy. Integrated Coastal Management (ICM) is "…a process that unites government and community, science and management, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal ecosystems and resources." The overall goal of ICM is to improve the quality of life of human communities who depend on coastal resources while maintaining the biological diversity and productivity of coastal ecosystems.

Ecological theory as described in standard textbooks on ecology, is seldom applied directly to coastal zone management in Southeast Asia. But ecological knowledge — including not only theory, but also facts, observations, research results, observations, syntheses, models, and methods of investigation — has been extremely important in developing approaches to a wide range of environmental problems. This stems from the "man-environment" model, given below, which identifies the essential and crucial role of ecology:

ENVIRONMENT	**《ECOLOGY》**	**MAN**
natural processes and components	**《functional interrelations》**	**human needs and activities**

From the model, ecology is the key to a sustainable use of the environment and its resources. This is because it investigates the nature of the linkages inherent in or resulting from the use of these resources by humans, defining limits (carrying capacity). Thus, it provides the information and a means by which these relationships could be understood so that the necessary actions could be implemented.

But ecology alone is not sufficient to address effectively coastal zone management issues. No matter how much biologists know about the population dynamics of the sea cow or the ecosystem dynamics of seagrass beds, it will not be possible to protect or use them sustainably unless we understand the human causes and consequences of their increasing rarity. Having better information about populations, species, and ecosystems is essential, but not sufficient: Decision-makers also need much better information about human causes and consequences of protecting and using living resources. Our success or failure is rooted in our cultures and economic activities. These can be forces for conservation and sustainable use, or they can be forces that eliminate species and ecosystems. For life in the sea, the diversity of human cultures offers both promise and risk, but in Southeast Asia, the promise outweighs the risk. Indeed, coastal zone management issues are deeply rooted in society and culture, which require, for their resolution, significant input from ecology. It is becoming more acceptable that, as Salwasses (1993) puts it, "…long term management of resources must be adaptive rather than deterministic. And it must be economic and political rather than scientific."

These understanding and implementation are realized only when the importance of nature and a healthy natural environment to human welfare is fully reflected in economic planning and decision-making, i.e., when ecological data are translated into useful information for planners and decision-makers. What is most lacking is a simple but effective method for local planners and decision-makers to decide on the best alternative use of a particular natural area, including the option to conserve it in its natural state (de Groot, 1992).

Hence, the current problem facing Philippine decision-makers is how to manage the apparently conflicting activities and uses of the coastal zone and its marine environment. Coastal resources are impacted directly by activities in the zone, and activities well inland, which are transmitted by rivers or carried by currents by other regions and countries. Therefore, the management of coastal zone requires a multi- and inter-sectoral approach. Control and management of the living resources of seagrass beds and mangrove forests, and the sediment areas between these systems must be a multi-sectoral responsibility, involving many government and private sectors at all levels. Here, the decision-making process must rely on science and technology, and make hard decisions for the long-term management of human uses of the coastal zone — decisions that will put to test the democratic process as some human activities will have to be curtailed.

14.9. The Challenges

Today's problems are a result of successes as they are defined in yesterday's terms. The Philippines needs good men and women who can make good plans. The planning process must start with a value discussion that ends up with general and operational goals: what kind of coastal development does the Philippines want and what kind of social, cultural and environmental qualities does its people want to keep or strive for? Because of great variety in culture and interests in the country, such goals should be decided after a comprehensive planning process with broad input from all interest groups. These comprehensive plans need to be tested for realism under conditions of limited resources and established environmental quality requirements. Recognizing that the regenerative capacity of the country is limited, as well as its resource base, a strong motivation exists for the use of carrying capacity philosophy as the basis for national planning. These relatively scarce resources must be managed in the context of competing demands, and the environment must be considered as the region's inhabitants change their social, technical, or economic activities.

Here, natural and social scientists and engineers have a social obligation to seek a solution. They should develop a stronger sense of ethical responsibility. Science and engineering are clearly necessary to allow us to use the world efficiently and to form a stable relationship with it, but they are not sufficient. Unless humanity addresses effectively the issues on population, excess consumption, inappropriate technology, and cultural insensitivity, science and engineering will not be able to help our ailing world.

In the longer term, sound management of coastal and marine ecosystems would depend on an educated community in which members understand the importance of a mix of conservation, development and community participation. Past, and probably present governments have not tried to educate the population towards a more realistic way of life, nor to convince them that because of globalization, for example, the world is shrinking, that modernization needs hard work, and that we are obliged to support the sustainability of our environment.

The science community needs to develop and nurture an ethic that views the seas as a resource in need of our stewardship and not simply a commodity. The extent to which local community participation in marine environmental protection and resource management can be fostered will be a significant factor in determining the quality of the marine environment and the availability of its resources in the future. Indeed, people of the Philippines have been "biting

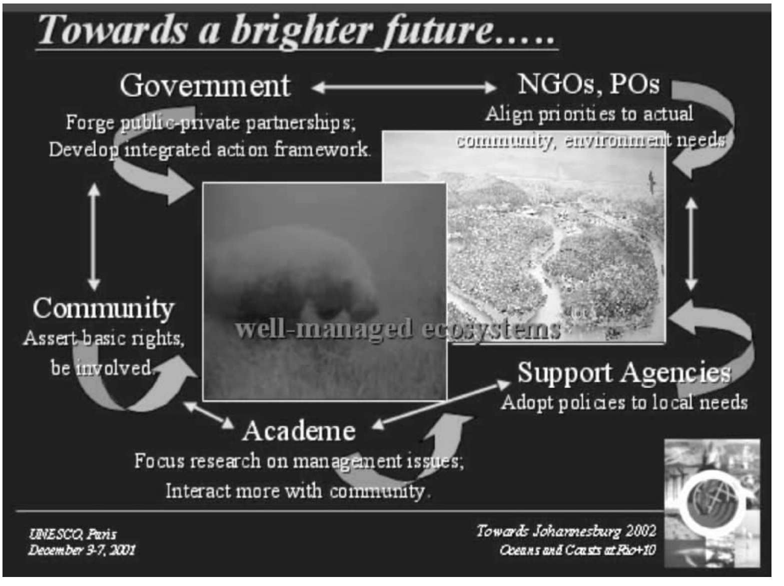

Figure 4: The "ways forward" in conserving and managing seagrass and mangrove in the Philippines (see Fig. 2 for related information).

the hand that has been feeding them for generations." In so doing they have been slowly foreclosing options for the future.

In relation to the role of stakeholders in the conservation and management process, Fig. 4 shows the ways forward in terms of what they can do to remove the impediments depicted in Fig. 2.

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